U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE UNIVERSITY OF IDAHO AGRICULTURAL EXPERIMENT STATION, E. J. IDDINGS, DIRECTOR.

SOIL SURVEY OF THE PORTNEUF AREA, IDAHO.

BY

H. G. LEWIS, OF THE U. S. DEPARTMENT OF AGRICULTURE, IN CHARGE, AND P. P. PETERSON, OF THE UNIVERSITY OF IDAHO.

MACY H. LAPHAM, INSPECTOR, WESTERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1918.]

WASHINGTON
GOVERNMENT PRINTING OFFICE
1921

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Soils,
Washington, D. C., March 24, 1921.

Sir: Under the cooperative agreement with the University of Idaho Agricultural Experiment Station, E. J. Iddings, Director, a soil survey of the Portneuf area was carried to completion during the field season of 1918.

I have the honor to transmit herewith the manuscript and map covering this work, and to recommend their publication as advance sheets of Field Operations of the Bureau of Soils for 1918, as authorized by law.

Respectfully,

Milton Whitney,
Chief of Bureau.

Hon. H. C. Wallace,
Secretary of Agriculture.

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Soil map, Portneuf area sheet, Idaho.

SOIL SURVEY OF THE PORTNEUF AREA, IDAHO.

By H. G. LEWIS, of the U. S. Department of Agriculture, In Charge, and P. P. PETERSON, of the University of Idaho.—Area Inspected by MACY H. LAPHAM.

DESCRIPTION OF THE AREA.

The area covered by this survey comprises approximately 1,162 square miles, of which between 50 and 60 square miles lie within the Cache National Forest.

It covers the western and greater part of Bannock County, which lies in the southeastern part of the State of Idaho. The northern, western, and southern boundaries of the area surveyed coincide with the northern, western, and southern boundaries of the county.

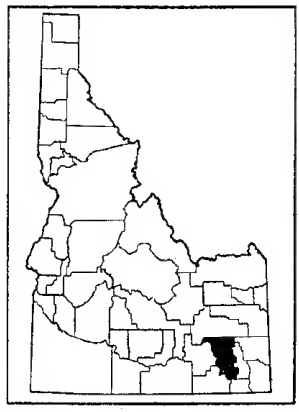

FIG. 1.—Sketch map showing location of the Portneuf area, Idaho.

The maximum width of the area along its northern boundary is 37 miles, while along its southern boundary it has a width of approximately 24 miles. From north to south it extends a distance of 54 miles.[1]

The area consists mainly of a number of mountain ranges, having a north-and-south trend, with included structural intermountain valleys.

The Bannock Range forms the divide constituting the county boundary on the west and merges on the south into the Malad Range, which extends into Utah. The Portneuf Range lies parallel to the Bannock Range and upon the east. Between these two main mountain ranges, or included within them, are the important Cache, Marsh Creek, and Portneuf Valleys, and numerous other smaller valleys or basins, among which may be named Hawkins, Garden Creek, Cottonwood Creek, Sunnyside, Pebble, and Rabbit Creek Basins. The country to the north of Pocatello opens out into a broad plain, a part of the Snake River Plains. A small valley

[1] The base map used in plotting the soils of this area, except in the part covered by the Preston, Fort Hall, Portneuf, and Paradise Valley topographic maps published by the U. S. Geological Survey, was constructed from a plane-table survey made by the soil survey party.

occurs near the head of the South Fork of Ross Fork Creek, which is bounded on the east and west by a portion of the Portneuf Range.

The Cache Valley, which extends into southeastern Idaho from Utah, is a part of the Bonneville Lake (Great Salt Lake) Basin. In the area covered by this survey it comprises a narrow belt extending from the southern boundary of the county to Red Rock Pass, which was the outlet of Lake Bonneville. North of the Cache Valley lies the Marsh Creek Valley, extending from Red Rock Pass in a northerly direction nearly to the town of Inkom. This valley is about 30 miles long from north to south and has an average width of about 8 miles. It is traversed by Marsh Creek, and from McCammon northward by both Marsh Creek and the Portneuf River. The Portneuf Valley is a narrow valley extending from Inkom west and northwest, parallel with the Portneuf River, to near Pocatello, where it merges into the Snake River Plains. The area is approximately 175 square miles.

Hawkins and Garden Creek Basins are of rather small extent, occupying a few square miles each near the headwaters of Hawkins and Garden Creeks. They are typical intermountain basins. Sunnyside and Pebble Basins, also of small extent, occupy a few square miles each along the Portneuf River near Lava Hot Springs and Pebble. Cottonwood Creek Basin comprises a few square miles lying along the headwaters of Cottonwood Creek, a tributary of Bear River. Rabbit Creek Basin lies to the north of Inkom on Rabbit Creek. Ross Fork Valley is situated on the headwaters of the creek of that name and merges into Rabbit Creek Valley over a comparatively low divide. Plate I, figure 1, is a general view of Ross Fork Valley. These different valleys constitute the principal farming areas of the survey. The topography of the area varies greatly, ranging from smooth and nearly level to rough and mountainous. In the agricultural sections it varies from smooth and nearly level to rolling and rough in places.

The topography of that part of Cache Valley included in the survey is smooth or nearly level in the lower valley floor (Pl. I, fig. 2) and rolling to steep in the more elevated parts. All this region was at one time covered by the waters of Lake Bonneville, which were from 200 to 400 feet deep. The deposits of this lake have been eroded since the waters receded, and this has given the rolling to steep topography of the higher lying parts of the valley. The smooth to rolling topography of the Lake Bonneville deposits give way on the west to the steep and mountainous slopes of the Malad Range and on the east to the steep slopes of the Portneuf Range.

The topography of the Marsh Creek Valley ranges from that of flat stream bottoms and smooth, gently sloping upland valley plains

along Marsh Creek to gently sloping and rolling country along the valley margins, where old alluvial fans have been covered by loessial material. The rolling and gently sloping uplands give way on the west to the steep mountain slopes of the Bannock Range and on the east to those of the Portneuf Range and are separated from the bottom lands along Marsh Creek by a steep, broken escarpment. As a whole the lands of Marsh Creek Valley are suited to agriculture.

The Portneuf Valley consists mainly of old valley-filling material which has been covered by wind-laid materials. The topography is gently sloping to smooth. The area in this valley suited to farming is very small. The Snake River Plains are smooth, undulating to gently sloping bench lands, all with a topography favorable for cultivation. The break between the plains and the bottom lands along the Snake River is very abrupt and is marked by a steep, narrow escarpment of Rough broken land. The first bottoms are comparatively smooth, but marked in places by slight hummocks and depressions.

The topography of the Rabbit Creek Basin and the small valley on the headwaters of Ross Fork Creek is rolling to gently sloping, the surface features resulting from erosion and eolian deposition. Sunnyside Basin likewise has a topography of the same origin, while the Pebble Basin consists of smooth to gently sloping first-bottom land along the Portneuf River. The nonagricultural portions of the area consist of steep, broken, and rough mountain slopes. Only a few small tracts scattered through this general region can be farmed, it being typically mountainous land, best adapted to grazing and forestry.

There is a wide range in elevation within the area. The farming section of the Cache Valley ranges from 4,750 feet at Oxford on the Oregon Short Line Railway to about 5,200 feet on the higher benches on the west and east sides of the valley. The Malad Range of mountains rises to an elevation of 7,000 to over 9,000 feet above sea level. The southern end of the Portneuf Range is not quite as high as the Malad Range. The elevation of Marsh Creek Valley ranges from 4,750 at McCammon to 4,854 feet above sea level at Downey. The rolling and gently sloping bench lands in this valley are several hundred feet above this, as the elevations given are the elevations of points on the Oregon Short Line Railway, which traverses the lower part of the valley. The Portneuf Range on the east of this valley rises to an elevation of 6,000 to 9,000 feet above sea level, which is approximately the same elevation as that of the Bannock Range on the west side. Hawkins and Garden Creek Basins range from about 5,000 to 6,000 feet above sea level. The elevation of the Snake River Plains is from 4,461 feet above sea level at Pocatello to 4,458 feet at Tyhee, on the Oregon Short Line Railway.

The plains give way on the east to steep broken slopes of the Portneuf Range. South Mount Putnam in this part of the Portneuf Range rises to an elevation of 8,989 feet above sea level. The elevation of Sunnyside and Pebble Basins ranges from 5,082 feet at Lava Hot Springs to 5,379 at Pebble.[2]

Cache Valley is devoid of trees, except where planted for shade. The lower slopes of the inclosing mountain ranges support a growth of aspen, poplar, ash, and pines. The floor of the valley representing the former bottom of Lake Bonneville supports a growth of greasewood and salt grasses, with a little sagebrush. The upland rolling and eroded parts support a growth of sagebrush. No part of the Marsh Creek Valley is forested. It supports only a growth of sagebrush and a little greasewood. The various creek bottoms support a growth of birch, cottonwood, and willow.

The slopes of Bannock and Portneuf Ranges have only a scant growth of trees, among which are aspens, poplars, junipers, and scattering pines. As a whole the mountain slopes are barren, except for a few scattered trees, sagebrush, and grasses. In the Snake River Plains the vegetation consists of sagebrush, greasewood, and grasses.

The valleys were all treeless in their natural state, except for narrow strips along the stream bottoms. Lombardy poplar, cottonwood. and elm are grown for shade and windbreaks.

The area is drained largely by the Portneuf River and its tributaries, of which Marsh Creek is the most important. The Cache Valley section of the area drains south into Bear River. The drainage ways have cut their valleys to all sections of the area, and all parts of it, with the exception of the flatter, lower lying parts of Cache Valley and a few small flats in other sections, are well drained.

Bannock County was organized in 1893. In 1919 the area of the county was reduced by territory taken to form Caribou County. The county seat is and always has been Pocatello. Originally the Fort Hall Indian Reservation covered the larger proportion of the northern part of the county, extending as far south as McCammon until 1902, when its present boundary was placed to the north and west of Pocatello. The Cache National Forest comprises a large part of the Bannock and Malad Ranges and the larger part of the more mountainous section of the Portneuf Range, to the north of the Portneuf River and south of the Fort Hall Indian Reservation. The extent of the National Forest land is shown on the accompanying soil map. The first settlements of white men in this region were made in the early sixties in the Marsh Creek Valley and near Soda

[2] Elevations along the Oregon Short Line Railway are taken from the records of that road; the other elevations are as given on topographic maps or as stated by other reliable authorities.

FIG. 1. GENERAL VIEW IN ROSS FORK VALLEY, 10 MILES EAST OF FORT HALL, ON INDIAN RESERVATION.

This shows the characteristic topography and native vegetation of the Portneuf very fine sandy loam.

FIG. 2.—VIEW OF THE CACHE VALLEY FLOOR, MAINLY OF THE TRENTON SOILS.

Springs, east of the area surveyed. These pioneers were ranchers, raising cattle, sheep, and horses.

The area is well supplied with transportation facilities. The Oregon Short Line Railway (Salt Lake-Butte Branch) passes through the area from north to south, while the main line extending westward from Granger, Wyo., passes through the northern part from east to west.

The population of Bannock County in 1910 was 19,242, of which 10,132 were classed as rural. Part of Bannock County was annexed to Franklin County in 1918, and a part was taken to form Caribou County in 1919. The population of Bannock County and its civil divisions in 1920, as issued by the Bureau of the Census, is as follows: Bannock County, 27,532; urban, 15,001; rural, 12,531; Pocatello, 15,001; Downey, 522; Lava Hot Springs, 662; McCammon, 467. Marsh Creek Valley, Cache Valley, and the Snake River Plains are to-day well settled. The population of the area is largely native born, though there are some Germans, Scandinavians, and others of foreign birth or extraction in the towns. A large part of the population has come from more eastern States.

Pocatello, the county seat and the principal town of the county, is situated in the northwestern part of the county. It has a good school system, and the Idaho Technical Institute is located here. The main shops of the Oregon Short Line Railway also are here. The town has paved streets, is well lighted, and in other respects is a model city. Inkom, McCammon, Arimo, Downey, Virginia, Swanlake, and Oxford are smaller towns in the Marsh Creek and Cache Valleys.

Lava Hot Springs, on the main line of the Oregon Short Line Railway, is noted as a health resort. All the towns and country districts have good schools. The roads of the area are in good condition. In most places the principal ones are surfaced with gravel.

CLIMATE.

The Portneuf area, Idaho, lies in the arid belt of the United States. The climate is invigorating, a characteristic of the Mountain Plateau region. There is a wide range in temperature, a low relative humidity, and a light annual precipitation. Weather Bureau records at Pocatello show mean temperature of 46.4° F. and 50.1° F. for spring and fall, respectively. The mean for the summer months is 68.6° F. While the afternoons are usually warm and the temperature sometimes reaches 100° F. or more, such hot spells have only a few days' duration and the nights are cool and comfortable. The winters are long and cold, but are normally dry. The mean temperature for the winter months is 27.6° F. The mean annual temperature is 49.2° F., with an extreme range of 122° F., or from the

absolute maximum of 102° F. recorded in July and minimum of −20° F. in February.

The mean annual precipitation at Pocatello is 12.93 inches. The rainfall is greatest during the spring months, with a mean of 5.97 inches, and least during the summer months, with a mean of 2.18 inches.

During the summer months precipitation occurs in thunderstorms of short duration. While there are no records strictly applicable to the Marsh Creek Valley, it is probable that the rainfall is greater than at Pocatello. Pocatello is situated at the end of the mountain ranges, while Marsh Creek Valley is inclosed between two ranges, and it often rains there when it does not at Pocatello. The vegetation in Marsh Creek Valley also would indicate more rainfall than on the Snake River Plains, and as recorded at Pocatello. The mean precipitation for the fall and winter months at Pocatello is 2.41 and 2.37 inches, respectively. Most of the winter precipitation occurs in the form of snow. The depth of snowfall varies greatly in different parts of the area, being light in the lower valleys, and ranging from 2 feet on the lower slopes of the mountains to as much as 6 or 8 feet in the valley basins within the mountain ranges. The last vestige of snow in the mountains usually disappears early in July. The melting snows of the mountains supply water for irrigation where storage reservoirs are used.[3]

There is usually enough rainfall during the spring months to germinate seeds without irrigation. The amount of rainfall in parts of the area enables the production of certain dry-farm crops, including wheat, oats, rye, and barley. Irrigation is generally employed in the production of crops on the Snake River Plains. On the lower mountain slopes of the Marsh Creek and other intermountain valleys crops of grain are produced with little or no irrigation.

A brisk wind movement is quite common in this region throughout the year. During the dry summer months dust storms are frequent. Much of the soil material of this area owes its accumulation to wind action. The mountains on the east and south of the Snake River Plains afford little protection from the cold winter winds, but in the valleys the mountains tend to moderate the climate of both winter and summer. The winds are prevailingly from the southwest in summer and northwest and north in winter.

The days of summer are characterized by long hours of warm sunshine with cool nights. The long hours of sunshine with the prevailing warm summer weather is favorable for the growth and maturity of crops. The average date of the first killing frost in the fall at

[3] The Blackfoot Reservoir is the source of water supply for the Fort Hall irrigation project, and the Portneuf-Marsh Valley reservoir supplies the Marsh Creek Valley irrigation project.

Pocatello is October 5, and the last in the spring is April 28. The earliest date of killing frost in the fall is September 13, and the latest in the spring is May 15. There is thus an average growing season of 159 days. The season is short for the production of the more tender varieties of fruits and vegetables.

An idea of the weather conditions of the area can be had from the following table, compiled from records of the Weather Bureau at Pocatello, Idaho. The elevation of this station is 4,483 feet above sea level.

Normal monthly, seasonal, and annual temperature and precipitation at Pocatello.

[Elevation, 4,483 feet.]

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1901).	Total amount for the wettest year (1906).
	°F.	°F.	°F.	Inches.	Inches.	Inches.
December	29.6	57	−16	0.86	1.62	1.47
January	25.1	57	−19	.66	.53	2.30
February	28.1	56	−20	.85	.80	1.35
Winter	27.6	57	−20	2.37	2.95	5.12
March	36.9	70	−12	1.75	.93	3.57
April	46.8	84	17	2.02	.52	1.16
May	55.5	93	24	2.20	.81	3.12
Spring	46.4	93	−12	5.97	2.26	7.85
June	64.2	99	32	.99	.15	1.66
July	71.2	102	38	.63	T.	.59
August	70.5	97	28	.56	.19	1.25
Summer	68.6	102	28	2.18	.34	3.50
September	60.9	92	21	.88	.71	.48
October	49.9	86	13	.98	.58	.46
November	39.4	69	− 1	.55	.72	.76
Fall	50.1	92	− 1	2.41	2.01	1.70
Year	49.2	102	−20	12.93	7.56	18.17

AGRICULTURE.

While the development of this area began in the sixties, it was not until the early part of the present century that agriculture became of any importance. Early settlers were stockmen, who raised cattle, sheep, and horses. The first farming was done in the Marsh Creek

Valley section, but about 1900, the year in which the Fort Hall Indian Reservation boundary was moved to the north, settlers began to take up the land thus opened for preemption and to engage in farming. The valley lands, which supported a growth of sagebrush and greasewood, were not difficult to bring under cultivation, and the development of the area was rapid. The recognized adaptation of the lands to the growing of grain crops was the important agricultural factor in this development.

Both dry and irrigated farming are carried on extensively in the area. There are two main irrigation projects in the area and many smaller ones. The Fort Hall irrigation project supplies water for the Snake River Plains west of the foothills of the Portneuf Range and extends from the county line on the north to Pocatello, on the Portneuf River, on the south. The Portneuf-Marsh Creek Valley irrigation canal serves lands in Marsh Creek Valley, lying on the east side of Marsh Creek, from Arimo southward to Downey. Other small irrigated tracts are scattered throughout the area.

The heavier and in many cases marshy soils of the valleys and the higher more rolling lands, which are too broken to be watered economically, are not irrigated. Wheat, oats, sugar beets, barley, and rye are the principal cultivated crops. The acreage devoted to alfalfa, cultivated grasses, and similar crops is also high. A little corn is grown, mostly for forage.

Under irrigation wheat, oats, sugar beets, alfalfa, Irish potatoes, truck crops, and small fruits do exceptionally well.

The raising of live stock, consisting of cattle, sheep, hogs, and poultry, and dairying are important in all the valleys. There is a large extent of land on the surrounding mountain slopes well suited for grazing. Bands of sheep and droves of cattle are to be seen scattered throughout the valleys. Omaha and Kansas City are the principal markets for the live stock of this section.

While the area surveyed includes only a part of Bannock County, some idea of the general trend of agriculture between 1900 and 1910 can be drawn from the census reports. In 1900 there were 865 farms in Bannock County with an average size of 209.8 acres, of which 87.9 acres was improved land. In 1910 there were 1,395 farms with an average size of 220.4 acres, of which 121.7 acres was improved land.

The proportion of improved land has gradually increased since 1910 as a result of improved methods in dry farming. At present (1918) the demand for land is great, and all the lower slopes susceptible of cultivation are being farmed.

According to the same authority, the value of farms and farm property advanced decidedly during the decade. In 1900 the assessed value of all farm property per farm was $4,390.26, while in 1910 it

was $7,855. The assessed value of land increased from $7.76 per acre in 1900 to $21.57 in 1910.

The farms are largely operated by owners; only 3.5 per cent were farmed by tenants in 1910.

The value of Bannock County's outturn of agricultural products not fed to live stock in 1900 was $762,034, and in 1910, $2,596,756.

Bannock County was reduced in area in 1919 by the cutting off of territory to form Caribou County. Its present area as given by the 1920 census is 1,175,680 acres, and the area surveyed thus covers 63.3 per cent of the county. The greater part of the agricultural lands of the county are included within the survey.

According to the 1920 census 38.6 per cent of the land area was in farms, of which 59.5 per cent was improved land. There were 1,719 farms in the county with an average size of 263.9 acres, of which 152.2 acres is improved land. The value of all property per farm in 1920 amounted to $15,530; and the assessed value of land per acre is given as $39.10. Of the 1,719 farms in 1920, 88.7 per cent were operated by the owners, 9.4 per cent by tenants, and 1.9 per cent by managers. The value of all crops in 1919 amounted to $3,931,816, and the value of all domestic animals January 1, 1920, was $4,482,721.

GRAIN FARMING.

Grains, produced under both irrigated and dry-farming methods, are grown extensively in this area. The general practice in dry-land farming is to allow the land to lie fallow in alternate years, during which it is plowed and harrowed, especially after each rain, to maintain a mulch and conserve the moisture for the following year's crop.

Most of the plowing is done in the fall months, some in the spring. Fall plowing is much to be preferred, as it tends to put the soil in better tilth. It also distributes the work, which is especially important if the spring months should be wet, which they often are. Fall wheat is usually sown the latter part of August or the early part of September, provided the soil contains sufficient moisture to germinate the seed. Most of the ground is plowed to a depth of 6 to 10 inches.

With proper cultivation yields of 25 to 30 bushels of wheat per acre are not uncommon, though the average is 12 to 15 bushels. Under irrigation yields of 20 to 35 bushels year after year are common. Grain farming on the nonirrigated areas is not so certain as on irrigated land. In some years the dry-farmed crop is very short, owing to deficiency in the moisture supply. Both winter and spring wheat are grown in the area, but the larger part is winter wheat, consisting of Turkey, Odessa, and Jones Fife, which rank in

the order named. The principal varieties of spring wheat are Marquis, Pacific, Bluestem, and Dicklow. In 1919 there were 74,735 acres of wheat grown in Bannock County, which produced 521,921 bushels. Wheat is grown on the upland soils almost exclusively, little or none being sown on the bottom-land soils.

Oats are of minor importance in comparison to wheat. The acreage for Bannock County, according to the 1920 census, was 6,414, and the production 123,484 bushels. The crop is used for feeding, either being allowed to mature grain or being cut green for hay.

Barley is third in acreage in the grains grown here. The acreage planted to barley in 1919 was 5,785, producing 56,873 bushels. Corn does not produce a paying crop in this climate, owing to the shortness of the growing season. A little is grown for forage and ensilage. In 1919 there were only 204 acres in corn, from which was harvested 3,078 bushels. A little rye is grown. The acreage in 1919 was 407 acres, which yielded 1,956 bushels. A few fields of beans were grown during the year of this survey (1918) with fair success. The 1920 census reports 22 acres in beans with a yield of 284 bushels.

ALFALFA AND GRASSES.

In 1919 there were 27,291 acres devoted to the raising of alfalfa in the county, producing 53,950 tons of hay. Tame and cultivated grasses produced 65,630 tons on 35,795 acres. There were 2,004 acres in timothy, which produced 2,644 tons, and 5,082 acres in timothy and clover mixed, producing 7,108 tons. Only a few acres were in clover, and at the present time clover alone is not grown to any extent. A little millet is grown, but this is a crop of minor importance. According to the census of 1920 there were 83,050 tons of hay and forage crops produced in the county in 1919. The acreage devoted to hay crops is increasing from year to year. The demand for winter forage for sheep and cattle is causing this increase. Practically all the alfalfa grown in the area is produced in the Snake River Plains, where the land is under irrigation, and under the ditches near Downey in Marsh Creek Valley. Small areas of alfalfa and cultivated grasses are grown in other irrigated sections.

Little or no alfalfa is produced under dry-farming methods. While this has been attempted in a few places, the plants tend to burn out and die for lack of moisture. Most of the alfalfa is seeded in the spring months, and only occasionally is a nurse crop of wheat or oats sown with it. The ground is plowed deep and is put in good tilth before seeding. The ordinary yield of alfalfa hay is $2\frac{1}{2}$ to 3 tons per acre per season. In some of the better fields yields of 5 tons are made. Usually there are two cuttings a year, though three are sometimes obtained. The third crop is light as a rule, as frosts

usually catch it. One to two irrigations are given for each cutting. Alfalfa is the principal cultivated hay crop on the Snake River Plains north of Pocatello. It is the aim of most of the farmers in this part of the area to get all their land seeded to the crop. Timothy, redtop, and wild grasses also are cut for hay. The lower lying poorly drained first bottoms support a growth of wild grasses yielding about 1½ tons of hay per acre, and the low-lying land along Marsh Creek is used almost exclusively for the production of this crop. According to the 1920 census wild grasses were cut from 11,357 acres, with a production of 14,610 tons.

Alfalfa hay sells for $8 or $10 a ton, though during recent years as high as $15 to $18 or more have been obtained. Wild hay is a little lower in price.

SUGAR BEETS.

Within the last few years the growing of sugar beets has been developed in the area. To-day many acres are devoted to the growing of this crop, and the acreage is gradually increasing. The beets are grown on the Snake River Plains and the lower lying irrigated section of Marsh Creek Valley, with a few acres scattered over other parts of the area where irrigation is practicable. The beets are grown on silty soils of the Snake River Plains and Marsh Creek Valley and on the McCammon soils near McCammon. The soils as a whole are deficient in humus and need applications of manure and the plowing under of stubble or other vegetation to produce the best beets. Sugar beets are often planted after alfalfa, in which case especially good results are obtained.

Land for beets is usually prepared by deep plowing in the fall, followed by a thorough pulverizing in the spring. The seed is planted in rows from 15 to 20 inches apart, and from 1½ to 2 inches deep. The growers usually enter into a contract with the sugar company for the thinning, pulling, and topping of the beets at a stipulated price of about $10 to $18 an acre. The beets are cultivated with special implements. Cultivation is shallow, the aim being to keep the soil level, so that the beets, which naturally stand in part above the surface, will have the air and sunshine necessary for their maturing. Hoeing is done often enough to keep down the weeds.

Proper irrigation of beets is very essential. From two to four irrigations are usually sufficient. The beets are cultivated to a depth of 2 to 4 inches after each irrigation. The yield of sugar beets in this area ranges from 10 to 20 tons per acre, with an average of about 15 tons. The 1920 census reports 2,433 acres in sugar beets with a yield of 19,671 tons.

The beets are sold under contract at a flat rate. For the last two years the price has been $10 a ton. Beets grown on the Snake River

Plains are shipped to a factory at Blackfoot, Idaho, and those grown in the Marsh Creek Valley and the southern part of the area go to Lewiston and Logan, Utah.

FRUIT.

Very little attention has been given to fruit growing in this area, owing largely to the fact that the climate is not very favorable for fruit production. The freezes in spring are usually late and injure the bloom. Apples are grown in a few places in small orchards, and in a few of the more favorably situated sections where frosts do not occur so late a good grade of fruit is produced. Most of the apples are consumed on the farm. Among the varieties are the Jonathan, Missouri Pippin, Black Twig, and Ben Davis. Peaches are almost invariably caught by the late frost and few are planted. There are several small pear orchards and the quality of the fruit is good. The Bartlett variety predominates. A few plums and cherries are produced. Of the small fruits, currants, gooseberries, raspberries, and strawberries do well. In a few localities the quality of the strawberries is exceptionally good. The small fruits are used for home consumption, either fresh or canned.

TRUCK CROPS.

In the vicinity of Pocatello some small truck farms are operated. On these cabbage, cauliflower, celery, beets, radishes, cucumbers, onions, asparagus, tomatoes, peas, and other vegetable crops are grown to supply local demands. All the hardier vegetables are grown in the gardens of farmers. A few watermelons and cantaloupes are raised for home consumption. Irish potatoes are a crop of some importance on the irrigated lands. The product is of very good quality. The yield ranges from 100 to 250 bushels per acre, with an average of about 150 bushels. The 1920 census reports 1,321 acres, yielding 183,120 bushels.

DAIRYING.

Dairy farming is proving quite profitable. Within the near vicinity of Pocatello there are several small dairy farms which supply the demands of the city. A large number of farmers in the Marsh and Cache Valleys ship cream and butter fat to Salt Lake City. A little cream is shipped to Pocatello. The dairy herds consist of Jersey, Holstein, and the native cattle, but it is only within the last few years that any attention has been given to the better breeds of dairy cows. The 1920 census reports 10,680 dairy cattle in the county.

Very little attention is given to the rotation of crops, but in dry farming the fields are fallowed every other year. In a few places lands under irrigation are used 2 years for alfalfa, 1 year for sugar beets, and 2 years for wheat. This seems to be a good rotation on some of the irrigated bench lands. Alfalfa, however, is usually grown for four or five years.

On most of the farms very little effort is made to increase the humus supply in the soil. A few farmers apply manure and the plowing under of wheat stubble and, where headers are used, of the straw, tends to maintain the supply. As a whole, the soils are low in vegetable matter, and the best management will include means to meet this deficiency.

Most of the labor on the farm is done by the farmer and his family. The cost of farm labor is very high at the present time (1918). The use of improved machinery, as in harvesting wheat with the combination harvester and thrasher, has done much to relieve the shortage of labor.

SOILS.

The soils of the Portneuf area have two characteristics prevailing, with somewhat slight variations, over the entire area. The parent materials vary from place to place over rather wide limits, but notwithstanding this fact there is a striking uniformity in general soil characteristics over the area, and such variations as occur do not run parallel to the variations in character of parent material.

The mature soils are those that have been in position long enough to have assumed the general features characteristic of the region as a whole and which should be regarded as relatively stable. Their characteristics are fixed, so to speak; are less subject to change, by natural forces, in the future than the less mature soils. The mature soils occupy about 70 per cent of the area surveyed, leaving out of consideration the Rough stony land, Rough mountainous land, and Scabland. They include the Ritzville silt loam, the Walla Walla silt loam, the various types of the Portneuf series, and most of the Winchester soils, though these may or may not show the characteristics of mature soils on account of their process of formation. The types of the McCammon and Bannock series belong in this group also.

The other soils of the area are young, consisting either of alluvial deposits accumulated in relatively recent times and the deposits of extinct lakes which, although much older than much of the alluvial deposits, are young as compared with the Ritzville and other mature soils.

The mature soils of the area are all light in color. The extreme range is from a light brown to a strong brown, or, possibly, in extreme

cases, a dark brown. None of the mature soils carry in the two upper horizons a percentage of lime carbonate high enough to cause effervescence in hydrochloric acid. In this they differ from the young soils, which, as a rule, effervesce at the surface or within a very few inches below it. In all cases lime carbonate has accumulated in the upper subsoil, the depth to this zone ranging from about 10 to about 20 inches. Although the surface soil has no accumulation of lime carbonate it has not been leached to any noticeable extent. Chemical analyses of soil developed under identical conditions and from essentially identical parent material disclose a good if not high percentage of all of the alkalies and alkaline earths, including those usually regarded as constituting the mineral elements of fertility. Like all light-colored soils these soils have a low content of nitrogen, the chief source of that constituent being the soil organic matter. In these soils the amount of organic matter is small, the percentage ranging under 4 per cent, while in the black soils of the eastern Great Plains it ranges up to somewhat more than 10 per cent. In mineral elements these soils are rich; in nitrogen they can not be considered rich.

The prevailing natural soil profile in the region, the profile of the virgin soil, consists of a surface horizon of loose, deflocculated material from 1 inch to 3 inches in thickness. It is always loose and always lighter in color than the immediately underlying horizon. Its color is usually grayish ranging to a very light brown. Immediately below this lies a moderately compact horizon, little, if any, heavier than the surface horizon but strikingly more compact. Its color in this area ranges from a light brown to a strong brown or possibly in extreme cases a dark brown. Its color determines the color of the cultivated soil throughout the whole region. It ranges from 8 to 10 inches in thickness, becoming lighter in color in the lower part. In exposures in excavations it shows a decided tendency to assume a columnar structure.

Beneath this horizon lies a horizon of loose, gray, highly calcareous material, usually about 2 feet in thickness, grading in its lower part into the unmodified parent material.

In those cases where the soil material is much heavier than normal these horizons are thinner than described and may even in rare cases not be noticeable at all.

This is especially true of the Oxford clay, owing in part to the very heavy material from which the soil has developed and in part to the pronounced color of the material itself. The heavy material has prevented the extension of soil-making forces to more than a few inches in depth and the pronounced color of the unmodified material tends to mask the soil color even where weathering has been effective. The subsoil consists of the unmodified parent material, and its color is merely that of that material rather than a soil color.

It was stated above that the color of the soil ranges from light brown to a strong brown. The distribution of these colors is not haphazard. The color referred to also is soil color and not the color of the parent rock. It is broader in its distribution than is that of any one kind of parent material in the area covered, and the widest variations of soil color occur in the soils from the same silty material. The color of the mature upland soils of all that part of the region lying below about 5,500 feet is light brown, regardless of the character of the parent rock, while that of the soils above that elevation is darker and in some cases becomes what may be described as darkish brown.

In the high basins such as the Hawkins and Garden Creek Basins in the western part of the area, that in the northeastern corner of T. 5 S., R. 37 E., and on the divide at the head of Ross Fork, as well as in some other places, the soil is uniformly darker than below the level mentioned. The silty soil in these localities has been differentiated from that derived from the same material at lower levels, the former being described as the Walla Walla silt loam and the latter as the Ritzville silt loam. The soils in the vicinity of the Portneuf reservoir approach the Walla Walla soils in character also, and if they had been identified with them, no serious error would have been committed. Upon careful consideration, however, it was concluded that their relationships were a little nearer those of the Ritzville.

On the basis of soil characteristics alone, without any reference whatever to characteristics of the parent material, the soils of the area fall into two rather well defined groups, which may best be designated as the brown group on the one hand and the very light brown group on the other. The brown group includes the Walla Walla, Ritzville, Downey, Oxford, Onyx, Hyrum, and Logan soils, while the very light brown group includes the Portneuf, Winchester, Bannock, Trenton, and Snake soils. The lightest colored of the former group, the Ritzville and Downey, do not differ widely from the members of the latter group, yet the difference is sufficient to justify the separation of the latter from the former. The difference is not merely a theoretical one based on some supposed influence due to slight difference in the character of the parent rock or in the processes by which the material was accumulated. The Ritzville silt loam has a brown soil, while the other soils just mentioned have a much lighter color. Since this color is soil color rather than rock color it is significant, in that it expresses the relative amounts of organic matter in these soils and through that the relative amount of nitrogen. The conditions under which these several soils have weathered are not sufficiently different to cause the formation of organic compounds of essentially different characteristics in the different soils. It is the quantity of organic matter present, therefore, rather than its charac-

ter that determines the difference in these soils, so far as that difference depends upon the organic factor.

The Portneuf and associated soils occur in the northwestern part of the county where the elevation is lowest and where the influence caused by nearby mountain ranges is least. The Ritzville soils, on the other hand, are confined to the valley belt traversed by the railway from the southern part of the county to Pocatello, and in the intermountain basins, at lower levels than the Walla Walla. Occurring in these higher valleys and nearer the still more elevated parts of the county they probably receive a greater rainfall and are certainly subjected to less rapid evaporation than those soils occurring in the northwestern part of the county. Their color is intermediate between that of the Portneuf and associated soils on the one hand and the Walla Walla silt loam on the other. They lie also at an intermediate elevation, above the Portneuf and below the Walla Walla.

The color of these soils seems to express clearly the differences in rainfall at different elevations in the county. The available rainfall records in the area are not sufficient to prove this since none are available, except for Pocatello. The record for Blackfoot Dam, a few miles east of the eastern part of the area, compared with that at Pocatello is suggestive of this relationship. Pocatello lies at an elevation of 4,460 feet and Blackfoot Dam at 6,100 feet. The rainfall at Pocatello averages 13 inches per year, while that at Blackfoot Dam averages about 17.5 inches per year. The relation of the latter place to higher mountains or other geographic features does not suggest any reason for differentiating it from other places of about the same elevation in the region. The mountains around the dam are not higher than those in other parts of the area, so that the increased rainfall would seem to be the result of the greater elevation alone, and there is no evidence at hand or conditions in the area that offer any strong suggestion that at the same elevations in other parts of the immediate region the rainfall would not be equally as much and that at intermediate elevations it would not lie between that at the dam and that at Pocatello.

In soil characteristics, with no reference to the character of the parent material or to the processes by which it was accumulated, the soils of the very light colored group do not differ essentially from each other except in texture. They differ, however, in most cases both in the mineralogical character of the parent material and in the processes by which the material was accumulated. These differences are described below in discussing the soil material.

The rocks of the region are principally quartzite, limestone, shale, conglomerate, sandstone, and basalt. Much of the soil material is derived from admixture of materials originating from these various

sources, but in places the soil-forming material is local or less variable and may be derived from a single formation or kind of rock. There are a few places where volcanic tuff is found, as in one place in Hawkins Basin and near Red Rock Pass. These occurrences are local and have little or no effect on the soils. In a few places east of Tyhee outcrops of rhyolite lava occur, but these outcrops have no great effect on the soil material, as the mantle of soil is here largely eolian in origin.

A large part of southeastern Idaho, especially the Snake River Plains, the country around Soda Springs and Bancroft, and along the Portneuf River, has been subjected to extensive lava flows. The open plains are still covered with the lava, and along the Portneuf River remnants of sheets which flowed through the Portneuf Valley are still found on the north side of the Portneuf River near Pocatello, around Inkom, and between the Portneuf River and Marsh Creek, extending about 4½ miles to the south of McCammon. (Pl. II, fig. 1.) No basalt is to be found in place south of Arimo in the Marsh Creek Valley. The lava flow at McCammon filled the bed of the Portneuf River, which seems at a later date to have flowed out over the lava, the rounded stone and gravel found on top of the beds suggesting such an explanation.

In the narrow gorges of the Portneuf River the lava has been removed by stream erosion. The soil materials originating in these various rocks were comminuted through various processes of rock weathering or disintegration and decomposition and accumulated in the localities, where the soils developed from them occur, by various agencies to be described below.

The most important single agency involved in the work of accumulation has been the wind. A mantle of eolian or wind-laid material has been deposited over the greater part of the area. That this process is still in operation is shown by the presence of a thin veneer of dust covering the country after every heavy windstorm.

The deposition of such material is in a large degree independent of topography, and through this agency there tends to be accumulated a layer of dust or somewhat coarser material over deposits accumulated by other agencies. Certain conditions of climate, topography, and sequence of geologic events have, however, favored removal by erosion of this material in certain localities more rapidly than in others, or have prevented its accumulation.

Other soil-forming materials, which, by their extent and uniformity, reflect the work of agencies of widespread influence acting through long periods of time, exist in the old valley-filling deposits of water-laid origin that occupy the greater part of the larger valleys and basins. Most of these deposits were laid down by

streams, and consist of old river terraces and of upland valley slopes built by alluvial fans formed by deposition of material by streams of steep gradient entering the valleys from hill and mountain areas. Other extensive areas consist of old deposits of fine sediments laid down in the waters of former lakes.

Small parts of the area forming river bottoms or areas subject to overflow by intermittent canyon streams have been subject to the accumulation of recent alluvial deposits. These include both recent flood plain and recent alluvial fan accumulations. Unlike the old valley-filling deposits, these more recent deposits have not been essentially weathered or modified since they were laid down.

In small and relatively unimportant sections of the area the soil material is essentially the result of the weathering in place of the underlying consolidated rocks. In an area exhibiting the wide range in character of rocks and in physiographic development of the present survey, the residual soil material would normally occupy a leading position in extent and variety. In the present survey it is relegated to a position of minor importance owing to the dominance of wind-laid and water-laid materials, by which the residual material has been veneered or more deeply buried.

The soil-forming materials of the area may be divided broadly into seven groups: (1) Eolian and loessial material; (2) old valley-filling material of stream-laid origin; (3) old valley-filling material of lake-laid origin; (4) recent alluvial-fan deposits; (5) recent alluvial deposits; (6) residual material; and (7) miscellaneous types or classes of material.

In each of these groups one or more series of soils have been developed. Under the first broad group we have the Portneuf, Ritzville, Walla Walla, and Winchester series. The soils of the first three series are derived from wind-borne material of fine, dustlike character. The Winchester series, while eolian in origin, comes from material of coarser texture, which has been drifted or blown along or near the surface. The soils in this series are not very extensive in the present area.

In the second group are the Bannock, Hyrum, and Downey soils. The material giving rise to these series includes stream deposits that are comparatively old and that were laid down either by the waters of the outlet of Lake Bonneville or by lateral streams. The subsoil and substratum of these types have not been affected by eolian deposition, while the surface has been to an appreciable extent. The substratum of these soils is a mass of stone and gravel; in some places is cemented.

In the third group are the Oxford and Trenton soils. These soils occur in that part of the survey covered by Cache Valley and have been derived from the clays and other sediments deposited in the

waters of Lake Bonneville. The Oxford series occurs along its outer margin or higher levels, while the Trenton soils occupy the floor of the valley.

From the fourth group the alluvial-fan phase of the Portneuf soils has been developed and from the fifth have come the Onyx, Logan, and the Snake series. The Onyx soils consist of recent alluvial deposits of brown color, and the materials in which originally came mainly from sedimentary rocks. The Logan series represents the dark colored to nearly black recent stream-laid deposits of similar origin. The Snake series is found in the first bottoms of the Snake River and includes soils ranging from a medium grayish brown to grayish-brown color, composed of materials of mixed origin.

In the sixth group is the McCammon series. The material giving this series has been derived mainly through weathering in place of basalt rock, though there is doubtless considerable eolian material in the surface soil.

In the seventh group is placed types or classes of miscellaneous character, consisting of Rough stony land, Rough mountainous land, Rough broken land, Scabland, and Muck and Peat.

The soils of the area, as a whole, are high in lime, especially in the subsoil below a depth of 8 to 10 inches. This is shown conclusively by tests with dilute acid. In texture the soils of the survey range from fine sand to clay; the predominant soil types are of silt loam and very fine sandy loam texture.

Thirteen distinct soil series are recognized and mapped. In these series there are included 16 soil types and 6 phases. In addition 5 miscellaneous types or classes of material are shown on the map. A brief description of the several series follows.

The surface soils of the types included in the Portneuf series are light grayish brown to light gray or light brownish gray and the subsoils light gray to gray. The structure is loose and open throughout the 6-foot profile. Both soil and subsoil are calcareous below the immediate surface material. The content of organic matter is small. The soil material ranges from 4 to 10 feet or more in depth and is underlain by bedrock or by unconsolidated old valley-filling material. The soils in this series are derived from eolian deposits. The types occupy gently sloping, treeless, bench lands, rolling upland, and foothills. Drainage is well developed to excessive.

The surface soil of the types included in the Ritzville series are light brown to brown and the subsoil yellowish gray to gray. The soil and subsoil are in most places calcareous to within a few inches of the surface. The soil material is usually deep, but in some places the stony and gravelly old valley-filling material lies within a few feet of the surface. This series consists of fine textured soils derived from eolian material. They occupy the rolling uplands of

Marsh Creek Valley and other intermountain valleys. Drainage is well developed and in places excessive.

The soils of the Walla Walla series are dark brown in color to an average depth of about 7 inches. This top layer normally grades into a brown or yellowish-brown stratum low in organic matter and lime carbonate. It is in most places thin, rarely exceeding 6 inches, and may not be present at all. This horizon passes into a gray or pale-yellowish highly calcareous material, powdery when dry. It varies in thickness, but is always present in the maturely developed soil. Beneath it lies the parent material, consisting of wind-blown fine-grained sediments, usually designated as loess. The dark-brown horizons do not effervesce in acid. In the virgin soil the dark-brown horizon is usually rather compact and has a more or less well-defined columnar structure. When plowed for the first time this horizon turns up into clods which are not difficult to break down. These soils occur in regions of low rainfall—from 14 to 18 inches—which varies, however, with the latitude and elevation. They lie intermediate between the darker soils, such as the Palouse and Marshall, on the one hand and the lighter colored Ritzville on the other.

The types included in the Winchester series have gray or dark-gray to brownish soils and subsoil, the color resulting from the mixture of light-colored quartz and dark-colored to black basalt particles. Both soil and subsoil have an open porous structure. They are low in organic matter and effervesce, as a rule, in hydrochloric acid at a depth ranging from 12 to 24 inches. The soil represents material which has been rolled or blown over or near the surface and which differs from the Ritzville and Portneuf materials in having a coarser texture and in showing the effects of wind action in its hummocky surface. The topography in general varies from smooth, or slightly hummocky, to ridged. Drainage is excessive.

The soils in the Bannock series are light brownish gray to light gray with minor light grayish brown variations, and the subsoil is brownish gray, yellowish gray, or gray. The surface soil is normally calcareous. It is deficient in vegetable matter, as is indicated by the light color, which is brown in the moist material. The subsoil is more compact than the surface soil and somewhat granular in structure, the granules consisting largely of soft lime-cemented lumps or nodules. As a whole, the soil material of this series is not very deep. It is underlain by a substratum composed of rounded bowlders, gravel, and sand, the coarser material usually being coated with lime. The soil-forming material is derived from old stream-laid valley-filling material, including some old alluvial-fan deposits, having their source in a variety of rocks, but apparently mainly from quartzite, limestone, and basalt. The surface soil contains an

admixture of eolian material, which has been deposited from the atmosphere or washed in from adjacent loess-covered slopes. The topography is smooth and gently rolling to undulating. The soils are for the most part well drained.

The surface soil of the types in the Hyrum series is, when dry, dark reddish brown or dull brownish red to dark purplish brown or chocolate in color, while the subsoil is lighter brown or grayish, usually with a more or less pronounced purplish tint. The subsoil is compact and stratified, and the substratum of old lake-laid clays and silts is compact and relatively impervious. As a rule the two upper horizons do not effervesce in acid, but the subsoil is always highly calcareous. The series is derived from old lake-laid sediments of fine texture occurring along the higher shore lines of Lake Bonneville. The topography is rolling to steep and broken. The soils are well drained and free from accumulations of alkali.

The types included in the Downey series have light-brown to brown or grayish soils, and a light-grayish brown to gray subsoil. The latter is calcareous and is somewhat compact and granular in structure and rests upon a layer of rounded stone, gravel, and finer interstitial material cemented with lime in the lower portions. This hardpan lies in most places within the 3-foot section. In exposures it is seen to have a thickness of 10 to 15 feet or more. The Downey soils are similar in origin, mode of formation, topography, and drainage conditions to the types of the Bannock series, from which they are distinguished by a darker color and a more firmly indurated substratum. The hardpan material has been deposited mainly by the drainage waters from Lake Bonneville debris. The surface soil is in part modified by the admixture of eolian deposits; the subsoil is largely residual from the older material. The series occupies smooth, gently sloping to slightly undulating terraces. Surface drainage is well developed, but subdrainage is retarded by the hardpan substratum.

The Hyrum series includes types with medium or rather dark brown soils, resting on a subsoil of rounded fine gravel and sand, very loose and incoherent, the gravel showing white incrustations of lime. This series of soil is similar to the Bannock series; in general features it is somewhat darker but has a stratified porous substratum. It is derived mainly from old stream terrace deposits. The fine surface soil material has been modified somewhat by later admixtures of eolian deposits. The series occupies nearly level old stream terraces and gently rolling to sloping areas of old valley-filling material.

The surface soils of the types in the Oxford series are dull brownish red, purplish red, dark purplish brown, or deep chocolate brown. The subsoils are heavy and compact and brown or gray, with a more

of less pronounced purplish or pinkish tinge and mottled with lime concentrations. When viewed under moist field conditions, the red tint in the surface soil is pronounced, and the soils are locally known as red soils. The surface soil usually effervesces with dilute acid and the subsoil is highly calcareous and frequently marly. The substratum is a compact stratified lake-laid clay and silt, in places with underlying or included fine sand, and of pinkish to gray color. The series is derived from old lake-laid deposits originating mainly from limestone, quartzite, and shale. The soils occur about the margins of the Bonneville Basin and are of undulating or sloping to eroded topography. Surface drainage is well developed, and the soils are retentive of water. They occupy treeless plains in arid or semiarid regions.

The surface soils of the types in the Trenton series are light grayish or brown to slightly pinkish brown and the subsoil is pinkish brown to slightly salmon colored, in many places mottled with white, red, or greenish streaks and stains. The soil material is quite deep. The subsoil is highly calcareous, and there is in many places a considerable amount of lime in the surface soil, as shown by tests with hydrochloric acid. The soil is retentive of moisture and is naturally wet and cold. The Trenton series is derived from materials deposited by the waters of lakes. The materials giving rise to this series originated in many different rocks, including igneous, metamorphic, and sedimentary formations, limestone probably predominating. In this area the series occupies the relatively low and flatter part of the Cache Valley. Drainage is for the most part poor. As mapped, small areas of dark-colored, poorly drained soils are locally included, which if more extensive would have been placed in a distinct series.

The surface soils of the types in the Onyx series are brown to dark brown and the subsoil lighter brown to gray. The soil material is ordinarily several feet deep. It is in most places mildly calcareous and well supplied with humus. The subsoil is moderately compact and distinctly calcareous. The soils of this series are composed of recent stream-laid deposits occupying present flood plains or slightly higher lying recent alluvial terraces. Locally associated areas of alluvial-fan deposits are included. The materials are derived mainly from limestone, quartzite, and shale. Some areas are subject to occasional overflow, but otherwise drainage is fairly well established, there being only a few small tracts of poorly drained land of this series. The surface, as a whole, is smooth to gently sloping, but is broken in places by winding sloughs and stream channels. It supports, in its virgin condition, a growth of sagebrush with some willows and oaks and small grass along the streams.

The surface soils of the Snake series when dry are characteristically dark brown, medium grayish brown, or dark grayish brown.

The subsoil is light grayish brown to gray. The brown tint in the surface soils varies with the amount of organic matter present. When moist the color is in places nearly black. Both surface and subsoil are calcareous. At a depth of 8 to 15 feet the underlying material consists of gravel. The soils consist of recent alluvial deposits, occupying the flood plains of the Snake River bottoms. The soil material is derived from a variety of rocks, including basalt, rhyolite, and other volcanic material, quartzite, and other metamorphosed sedimentary and sedimentary rocks. A part of it comes from unconsolidated loessial and lake-laid deposits. The topography is smooth and flat or gently sloping in the direction of the stream flow, with slight ridges and depressions. In places it is cut by numerous stream channels. Drainage is rather poorly developed and the lower lying areas are subject to overflow. In most places a high water table exists, and local accumulations of alkali occur in the heavier textured soils.

The surface soils of the types in the Logan series are dark gray to black, in places with a brownish tinge. The subsoils are dark brownish gray or dark gray to drab. The two upper horizons in the virgin soil do not, as a rule, effervesce in hydrochloric acid, but the subsoil is uniformly highly calcareous. The soil in most places contains much organic matter. The materials giving this series consist of recent alluvial deposits occupying present flood plains. They are derived from a variety of sedimentary rocks among which limestone is prominent. The surface in general is smooth to gently sloping, but broken in places by meandering sloughs and stream channels. Drainage is poorly established, and the lower lying bodies are wet throughout the greater part of the year. Alkali has accumulated locally.

The types included in the McCammon series have rather light reddish-brown to dark-brown soils and a lighter brown to rusty brown subsoil, mottled with gray, the mottling becoming more pronounced with depth. The soil material is calcareous below the immediate surface. The series is fairly uniform in texture and color in the present survey. The content of organic matter is moderate. The McCammon soils lie on the lava flows and have a smooth and gently sloping to undulating topography. Drainage is usually well developed. The soil material is mainly residual from the underlying basalt. It has, however, as occurring in this survey, been influenced by eolian material deposited on the surface and in places to some extent by water-laid material. The larger part of the soil material below the depth of a few inches is mainly residual from basalt.

The following table gives the name and the actual and relative extent of each soil type mapped in the area:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Rough mountainous land	335,936	45.2	Portneuf silt loam, alluvial-fan phase	8,192	1.1
Ritzville silt loam	135,168	18.2	Oxford clay	5,504	.7
Rough broken land	46,528	6.3	Winchester fine sand	4,992	.7
Onyx loam	19,584	4.7	Hyrum gravelly silt loam	3,958	.5
Light-textured phase	15,936		Winchester sandy loam	3,904	.5
Portneuf very fine sandy loam	32,704	4.4	Trenton silty clay loam	3,264	.4
Rough stony land	28,224	3.8	McCammon loam	1,920	.4
Bannock very fine sandy loam	10,240	2.8	Shallow phase	832	
Stony phase	8,256		Portneuf silty clay loam, alluvial-fan phase	1,408	.2
Shallow phase	2,240		Logan fine sandy loam	384	.1
Walla Walla silt loam	19,776	2.7	Muck and Peat	384	.1
Snake fine sandy loam	14,976	2.0			
Snake clay	11,456	1.5			
Logan silty clay loam	10,624	1.4			
Scabland	8,832	1.2	Total	743,680	
Downey silt loam	8,448	1.1			

PORTNEUF VERY FINE SANDY LOAM.

The surface soil of the Portneuf very fine sandy loam, to a depth of 12 to 20 inches, is a light gray or light brownish gray to gray very fine sandy loam having a very smooth velvety feel, a friable structure, and a low organic-matter content. It is of silty texture and as mapped may include some areas of silt loam. The subsoil, to a depth of 6 feet or more, is typically a light brownish gray to gray very fine sandy loam or silty loam, with about the same structure as the surface soil. Only in a few borings did it appear to be appreciably more compact. The type is very uniform in color, texture, and structure.

The topography of this type is gently sloping to rolling, and in places it has an erosional topography, having been dissected by numerous small stream courses. As a whole the surface is favorable for cultivation. The type is well to excessively drained, and there is little or no alkali present. The surface horizon and, as a rule, the subsurface horizon are not highly calcareous, but the subsoil below a depth of about 12 inches is uniformly so. That the soil is deficient in vegetable matter is shown by its light color. The native vegetation is sagebrush, grasses, and in a few places at the foot of the mountain slopes a little aspen and juniper. Only a small part of the type has been placed under cultivation, and practically all this is dry farmed. The cultivated area is used for grain production, but owing to the light rainfall the growth is uncertain, and only in exceptional years does the grain mature.

The amount of rainfall is apparently less where this type occurs than on much of the Ritzville silt loam. The light color and low content of humus as contrasted with the Ritzville soil also indicates that the moisture supply is much smaller and insufficient for practical dry farming. If irrigation water could be brought to it, the land would be very desirable, as it lies near Pocatello and thus within easy reach of markets. As much as 25 bushels of wheat or barley per acre have been obtained on this soil in years of ample rainfall. The Portneuf very fine sandy loam ranks low among the farming soils of the area. Very few tracts of land of this type are being sold except as building sites near Pocatello.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Portneuf very fine sandy loam:

Mechanical analyses of Portneuf very fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
540719	Soil	0.1	0.2	0.2	3.1	49.3	39.1	8.1
540720a	Subsoil	.0	.1	.2	2.8	43.7	46.2	7.3

PORTNEUF SILT LOAM, ALLUVIAL-FAN PHASE.

The surface soil of the Portneuf silt loam, alluvial-fan phase, to a depth of 15 to 20 inches, is a light grayish brown to light brownish gray silt loam having a smooth floury feel though relatively high in very fine sand. The subsoil, which extends to a depth of 6 feet or more, is a lighter grayish brown to light-gray or yellowish-gray material of similar texture. The subsoil material is very loose in structure, only in a few places showing any compactness, but soft, slightly cemented calcareous lumps or soil aggregates occur. At depths of 4 to 10 feet there occurs a bed of water-laid gravel, stone, and sand. This bed is prominent in the vicinity of Pocatello, but does not lie near enough the surface to interfere with cultivation.

The Portneuf silt loam, alluvial-fan phase, is fairly uniform in color, texture, and structure throughout its distribution in the northwest part of the area near Pocatello. Much of the included soil material is slightly darker or browner in color than the typical Portneuf soils. It is not very extensive, covering in all only a few square miles. The phase is high in lime but low in humus. On the whole the topography is favorable for cultivation. The soil occupies gently sloping alluvial fans of recent formation and the lower gently sloping areas at the foot of the steeper upland slopes. Drainage is for the most part good, but in local areas of gentle slope and others with a high water table there may be at times a little excess moisture.

The phase owes its origin to deposition, by minor streams and surface wash, of eolian materials carried down from the adjacent uplands and laid down as fans over the lower lying lands of the valleys. The larger part of the phase is farmed under irrigation. (Pl. II, fig. 2.) Wheat, sugar beets, alfalfa, and truck are the principal crops. Wheat yields from 20 to 40 bushels, sugar beets from 12 to 20 tons, and alfalfa from 3 to 6 tons per acre.

In the vicinity of Pocatello there are several small truck farms growing Irish potatoes, cabbage, lettuce, beets, celery, peas, and other vegetables. The soil, with good cultivation and irrigation, gives excellent yields of these crops. Land of this phase is very much in demand. Practically all of it is now in cultivation and very little is for sale. The selling prices range from $150 to $300 an acre, depending largely upon the distance from Pocatello.

The following table gives the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil material of the Portneuf silt loam, alluvial-fan phase:

Mechanical analyses of Portneuf silt loam, alluvial-fan phase.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
540711	Soil	0.1	0.2	0.2	2.0	45.0	43.9	8.4
540712a	Subsoil	.0	.1	.2	1.8	43.8	42.5	11.4
540712b	Lower subsoil	.0	.0	.1	2.2	34.2	49.1	13.9

PORTNEUF SILTY CLAY LOAM, ALLUVIAL-FAN PHASE.

The surface soil of the Portneuf silty clay loam, alluvial-fan phase, to a depth of 25 to 40 inches, is typically a light-brown to rather dark grayish brown silty clay loam. The subsoil to a depth of 6 feet or more is a light yellowish brown to brownish-gray slightly compact silt loam or silty clay loam. Gray predominates in the lower part of the 6-foot section. A few small lumps occur in the subsoil. These consist of soft lime cemented nodules or aggregates. In color, texture, and structure the phase is generally uniform over the area mapped, but in a few places in the lower lying spots some of the material is of grayish to dark-brown color and some of it is of rather light texture, more nearly a silt loam.

This phase is of small extent. One of the largest bodies lies about 2 miles north of Downey. Only a few other spots are mapped. This phase owes its origin to deposition of alluvial material washed from the adjacent uplands, which are principally covered with the loessial soils of the Ritzville series, with an admixture of some material derived from the various rocks of the mountain sides. The phase occupies gently sloping alluvial fans of smooth topography. All of it has a surface suitable for farming.

In its virgin condition the soil supports a heavy growth of sagebrush and grasses. It contains in many places considerable humus and is well supplied with lime. It is free from injurious accumulations of alkali. The larger part of the phase is under irrigation. Grain, sugar beets, alfalfa, and potatoes are grown. Wheat yields from 20 to 35 bushels per acre year after year. Sugar beets produce 12 to 20 tons per acre and alfalfa from 3 to 6 tons per acre in three cuttings. Irish potatoes do well, yielding from 150 to 250 bushels per acre. The phase is of very small extent, but it is considered one of the best soils in the area. It is easily worked.

This soil is sold in conjunction with the surrounding types. If sold alone, it would probably bring from $100 to $150 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Portneuf silty clay loam, alluvial-fan phase:

Mechanical analyses of Portneuf silty clay loam, alluvial-fan phase.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
540721.....	Soil.....	0.0	0.1	0.0	1.4	19.7	60.0	18.7
540722.....	Subsoil.....	.0	.2	.2	2.2	27.8	51.6	18.0

RITZVILLE SILT LOAM.

The surface soil of the Ritzville silt loam, to a depth of 12 to 20 inches, is a light-brown to brown velvety silt loam, relatively high in very fine sand. In a few places there is some gravel associated with the material but not enough to affect cultivation. The subsoil to a depth of 6 feet or more is a yellow-brown to gray silty loam or silt loam somewhat more compact and granular in structure than the surface soil. The granules consist of lime-cemented lumps which break down readily. The gray color becomes more pronounced with increasing depth.

The Ritzville silt loam is fairly uniform in color and texture. A variation of somewhat darker brown color is found in the Hawkins and Rabbit Creek Basins. A larger content of humus in the soil which has resulted from heavier precipitation causes this difference. The snowfall is heavier and remains on the ground longer in these elevated basins than in the larger more open valleys. In a few places a slightly reddish or reddish-brown subsoil occurs. This condition exists along the margin of the uplands where bordered by escarpments of Rough broken land developed in the vicinity of stream courses. The largest area of this character lies along the margin of the bench lands about 3½ miles west of McCammon. The variation is, however, of minor importance.

The Ritzville silt loam is the most extensive arable soil type in the area. It occupies the gently sloping or rolling areas of the bench lands of Marsh Creek Valley, the rolling to rough parts of Rabbit Creek and Hawkins Creek Basins, and the rolling and eroded areas of other uplands and bench lands scattered throughout the survey. The topography is in general favorable for cultivation, but some of the land is strongly rolling and broken. The larger part of the type is dry farmed, but in a few places in the smoother sections crops are irrigated.

The type is well to excessively drained. The water table lies at considerable depth. In a few places the lower subsoil, from 50 or 60 inches downward, is slightly moister than above, but in most places it is dry throughout the 6-foot section. There is little or no alkali present in this soil. The native vegetation consists of sagebrush and bunch grass and other grasses. It is treeless except in the moister places in the intermountain basins, where there is some aspen and cottonwood. Practically all the type of favorable topography is under cultivation and it ranks high among the dry-farmed soils.

Wheat is the principal crop. A few scattering areas are in rye, oats, and barley, but these crops are of minor importance compared to wheat. In a few places on the lower levels or where the soil is irrigated some sugar beets, Irish potatoes, and alfalfa are grown with good results. The soil responds readily to good cultivation and to irrigation.

The yield of wheat ranges from 15 to 25 bushels per acre. Most of the farmers fallow the land one year, planting wheat in the fall for the following year. The soil is easily worked and the fields are in good tilth. Oats yield from 30 to 75 bushels. Sugar beets, under irrigation, produce 10 to 20 tons per acre and potatoes from 100 to 200 bushels. Alfalfa where irrigated produces 3 to 5 tons per acre per season.

This type of soil is in demand for dry-land wheat farming. The price ranges from $30 to $75 an acre, varying with the location and improvements.

The following table gives the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of this type:

Mechanical analyses of Ritzville silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
540707	Soil	0.1	0.1	0.0	0.8	43.5	48.2	7.4
540708a	Subsoil	.0	.1	.4	3.7	49.0	41.5	5.5
540708b	Lower subsoil	.0	.1	.3	5.3	44.6	38.6	11.2

FIG. 1.—VALLEY OF THE PORTNEUF RIVER, NEAR PORTNEUF, SHOWING ALLUVIAL LANDS AND, IN MIDDLE DISTANCE, ESCARPMENT FORMED BY LAVA FLOW.

FIG. 2. FIELD OF SUGAR BEETS ON PORTNEUF SILT LOAM, ALLUVIAL FAN PHASE, 3 MILES NORTH OF POCATELLO.

WALLA WALLA SILT LOAM.

The surface soil of the Walla Walla silt loam consists of 10 to 20 inches of dark-brown mellow silt loam. The upper subsoil, from 10 or 20 inches to 36 or 40 inches, is a lighter brown, yellowish-brown, or slightly grayish silt loam. The lower subsoil, to a depth of 6 feet or more, is a distinctly gray-colored silt loam, somewhat more compact than the material above. Small granules of soft lime-cemented material are present in the lower part of the soil section.

This soil closely resembles the Ritzville silt loam, the main difference in the two types being the darker color and higher humus content of the Walla Walla. This color difference is due largely to the greater supply of humus in the soil, a result of heavier precipitation and consequent higher moisture content.

The Walla Walla silt loam is developed in the higher mountain basins. It is mapped in the Hawkins Creek, Garden Creek, and Rabbit Creek Basins and Ross Fork Valley, but is not extensive, occurring in comparatively small bodies.

The type is well drained, practically all of it has a topography favorable for cultivation, and a large part of it is dry farmed. The topography is gently sloping to rolling. The type is better supplied with moisture and retains it better than the Ritzville soils.

A large part of the type is used for the production of wheat and other grain crops, for which purpose it ranks high. Crop failures from drought are not so common as on the lower lying lands. Occasionally frosts are more common in the higher lying Walla Walla soils than in the lower lying Ritzville soils, but on the whole better crops are produced.

The grain yields on the average on this type are slightly higher than on the Ritzville soils.

WINCHESTER FINE SAND.

The surface soil of the Winchester fine sand, which extends to a depth of 15 to 20 inches, is in general a gray, dark-gray, or brownish fine sand containing in places a conspicuous amount of coarse sand particles. Upon close examination the color presents a "pepper and salt" appearance, the result of the light-colored quartz and dark-colored to nearly black basaltic particles that form the principal constituents of the soil. The surface soil is low in organic matter but loose and porous. The subsoil is a light-brown to brownish-gray (pepper-and-salt colored) fine sand, with a structure like that of the surface soil. The material extends to a depth of 4 to 20 feet or more. There is a very small percentage of the grades of material finer than fine sand.

The Winchester fine sand is of small extent. It occurs along Ross Fork Creek in the northwestern part of the area and extends northward into Bingham County. It occupies areas of smooth, slightly hummocky to ridged topography, the larger part being slightly rolling and uneven. Owing to the porosity of the soil and the ridged topography it is well drained.

The soil is not retentive of moisture. It supports a growth of sagebrush, wild grasses, sand bur, thistle, and stunted cedar. All the type as mapped lies within the Fort Hall Indian Reservation. While it is below the irrigating ditches, none of it is farmed, owing to its sandy nature. It would be difficult to irrigate, owing to unevenness of the surface and the extensively porous nature of the material. If the irrigation were practicable the type could be used advantageously for the production of vegetables, melons, and truck crops.

A mechanical analysis of a sample of the soil of this type gave the following result:

Mechanical analysis of Winchester fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
540715.....	Soil.....	0.6	12.6	15.5	63.0	4.0	2.0	2.3

WINCHESTER SANDY LOAM.

The surface soil of the Winchester sandy loam consists of 15 to 20 inches of gray or light brownish gray light textured sandy loam, low in organic matter. There is a considerable amount of the finer textured sandy and silty soil material mixed with the coarser particles, but not enough to modify its porous structure. The soil shows the mixed pepper-and-salt color noted in case of the fine sand of the series. The subsoil to a depth of 6 feet or more is similar in color and texture to the surface soil, except that the color becomes more distinctly gray.

The Winchester sandy loam consists of wind-blown material recently accumulated and contains, therefore, a considerable quantity of carbonate material from the subsoils of the older soils of the region and from exposed areas of calcareous hardpan. This type occurs in the northwestern part of the area within the Fort Hall Indian Reservation, where it is closely associated with the fine sand type of the series. In topography it is similar to the Winchester fine sand, except that it is somewhat less hummocky or ridged, and as a whole is better suited for farming.

It is well drained, owing to the porosity of the soil and the slightly rolling topography, and rather unretentive of moisture.

A little of this type is under cultivation, where it can be irrigated easily. In its original state it supports a heavy growth of sagebrush, wild grasses, sand bur, and nettle, with a few scattered cedars. Good yields of alfalfa are obtained with irrigation. A little grain is also grown on the type with fair results. With irrigation the soil is well adapted to the growing of vegetables, melons, and other truck crops, and alfalfa.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Winchester sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
540713	Soil	1.7	20.3	11.9	27.5	17.1	15.2	6.3
540714a	Subsoil	1.1	18.8	15.2	37.6	18.7	5.2	3.6

BANNOCK VERY FINE SANDY LOAM.

The Bannock very fine sandy loam consists of 15 to 20 inches of light grayish brown or light brownish gray to gray very fine sandy loam, containing a few small gravel and some cobblestones. The subsoil, to a depth of 40 inches to 6 feet or more, is a light brownish gray to light-gray, somewhat compact though granular very fine sandy loam. The granules consist of small lime-cemented lumps which break down readily.

Some stone and gravel is encountered in the subsoil, which is underlain by a bed of cobblestones, gravel, and sand at depths ranging from 40 inches to 6 feet or more. The surface soil has been modified by an admixture of eolian material, but the subsoil material is strictly the result of the weathering of the underlying old valley-filling deposits.

The Bannock very fine sandy loam is developed principally on the Snake River Plains north of Pocatello. It has a relatively small extent. It has a smooth to gently rolling surface, marked by a few slight rises or swells and depressions. In general the surface is favorable for cultivation. This type originally supported a growth of sagebrush with some greasewood, salt grass, and other grasses.

It is treeless, except for the poplar and other trees planted for shade and windbreaks. The greater part of the type is under cultivation. All the type, except a few higher lying sections, is under the ditch from the Fort Hall Irrigation Project Canal. The soil is deficient in organic matter. It is calcareous within a few inches of the surface, and in the higher parts and some of the lower or flatter parts it is slightly affected by white alkali, as shown by barren spots. The level of the water table is in places near the surface.

The type is used principally for the production of wheat and alfalfa, with a few fields of sugar beets and potatoes. The larger part of the type is in alfalfa, which produces from 3 to 5 tons of hay per acre from two and in most years three cuttings. Wheat produces from 15 to 20 bushels, with an average of more than 20 bushels. Sugar beets yield from 10 to 20 tons and Irish potatoes from 100 to 200 bushels per acre. The general appearance of the farms of this type indicate a prosperous condition.

Land of the Bannock very fine sandy loam type sells for $60 to $150 an acre, the price varying with the nearness to Pocatello and the character of improvements.

Bannock very fine sandy loam, shallow phase.—The Bannock very fine sandy loam, shallow phase, has a surface soil consisting of 18 to 20 inches of a light brownish gray to gray very fine sandy loam, containing considerable fine quartz and quartzite gravel and some larger rounded stones. The subsoil to a depth of 20 to 36 inches is a light brownish gray to gray compact granular-structured very fine sandy loam, also containing considerable stone and gravel. A stone and gravel substratum, in places cemented into a hardpan, is invariably encountered within the 3-foot section.

This phase is similar in origin to the typical Bannock very fine sandy loam with which it is associated. It occurs in small isolated areas on slightly elevated ridges and flats. It is, as a whole, impregnated with alkali. Greasewood and salt grass are the characteristic vegetation, with scattering sagebrush. Only a small part of the land is under cultivation. It is not considered as valuable for farming as the typical soil, owing to the nearness of the gravel substratum to the surface and because of the occurrence of alkali.

In a few places, where it is irrigated, fair yields of wheat and alfalfa are obtained.

Bannock very fine sandy loam, stony phase.—The surface soil of the stony phase of the Bannock very fine sandy loam is a light grayish brown to light-gray very fine sandy loam, 10 to 12 inches deep, carrying a large percentage of rounded bowlders, smaller stones, and gravel. Below 10 to 15 inches the soil mass is impenetrable by the soil auger, owing to the large content of rock fragments which, with the interstitial finer materials, are in many places more or less cemented with lime. The stones and gravel consist principally of quartzite, limestone, and basalt.

The stony phase, as mapped in Marsh Creek Valley, is largely formed from deposits made by the outlet of Lake Bonneville. The finer soil material of the immediate surface is largely eolian in origin, while the lower part is residual from the old valley-filling material.

The Bannock very fine sandy loam, stony phase, occupies slight ridges, escarpments, and smooth areas in the Snake River Plains

and in the Marsh Creek Valley. It occurs as narrow strips and as small isolated bodies. It is not very extensive in this area. In Marsh Creek Valley the material included with this phase in all probability belongs to the Downey series, but owing to its small development and its low agricultural value it was included with the Bannock. None of the type is farmed, being too stony to admit of cultivation. It supports a growth of sagebrush and grasses, and is used for pasture where utilized at all.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the typical Bannock very fine sandy loam and of a sample of the soil of its stony phase:

Mechanical analyses of Bannock very fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
Typical soil:		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
540741	Soil	0.4	0.5	0.4	4.6	44.8	38.0	11.4
540742	Subsoil	.5	.5	.4	4.4	51.3	33.5	9.4
Stony phase:								
540737	Soil	1.5	2.0	1.2	5.1	41.4	39.3	9.6

DOWNEY SILT LOAM.

The surface soil of the Downey silt loam consists of 15 to 18 inches of brown to light-brown or grayish-brown silt loam, containing a little rounded gravel and a few large rounded stones. The subsoil, to a depth of 25 to 35 inches, is a lighter brownish gray to gray compact and somewhat lumpy or granular silt loam containing a smaller quantity of stone and gravel than the soil. At a depth of 25 to 35 inches the subsoil rests upon a hardpan or substratum of rounded stone and gravel mixed with finer material, somewhat cemented with lime in the upper part and very hard, of the character of a conglomerate, at depths of 3 to 10 feet.

The soil material is fairly uniform in color and structure. There are a few places, where the underlying gravel substratum outcrops, in which the type is in reality a stony to gravelly loam, but such areas are very small.

The Downey silt loam occurs in the Marsh Creek Valley exclusively, where it occupies the smooth, gently sloping to undulating bench land in the vicinity of Downey. The total area is only a few square miles. The type is derived from old stream-laid deposits of mixed origin.

The rounded stone and gravel in the substratum represents material which was deposited by the drainage outlet of Lake Bonneville when it flowed down Marsh Creek Valley. The surface soil, however, has been modified by eolian material.

The type seems to be well supplied with humus and the subsoil has a high percentage of lime carbonate, as shown by tests with hydrochloric acid. Practically all of it can be irrigated with water from the Downey ditch, and the larger part of it is under cultivation. Originally it supported a growth of sagebrush, a little greasewood, and grasses. There is little alkali in the soil—not enough to interfere with crop production.

Wheat, sugar beets, alfalfa, and Irish potatoes are the leading crops. Wheat yields from 15 to 25 bushels per acre, where properly irrigated; sugar beets from 10 to 15 tons; and alfalfa from 2 to 4 tons. Irish potatoes do well, yielding from 100 to 175 bushels per acre. This type is not considered as desirable as some of the other soils, owing to the shallowness of the soil material. The land sells for $40 to $75 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Downey silt loam:

Mechanical analyses of Downey silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
540725	Soil	1.4	1.2	0.4	1.5	26.6	56.2	12.9
540726	Subsoil	1.6	1.6	.4	1.5	26.7	56.0	12.1

HYRUM GRAVELLY SILT LOAM.

The surface soil of the Hyrum gravelly silt loam, to a depth of 6 to 15 inches, is a light-brown to brown gravelly silt loam, containing a large quantity of small waterworn gravel, from one-fourth inch to 2 inches or more in diameter, but little other material of the grades coarser than fine sand. The subsoil and substratum consist of a mass of rounded gravel and sand. The gravel is lime coated, and in places slightly cemented, though as a whole the material is porous. The gravel is principally quartzite, with some limestone. The bed shows stratification.

The Hyrum gravelly silt loam represents old stream-laid materials, deposited principally by the waters draining Lake Bonneville. The type occupies smooth stream terraces and slightly rolling areas in the older sections of the valleys. The type is well drained owing to the loose porous nature of the surface soil and subsoil.

The type is not cultivated to any extent as it is too shallow and gravelly and too quickly affected by drought for practical farming. A few small areas near Arimo, where plenty of water can be had for irrigation are used for truck growing. Here good results are obtained.

Practically all the type is in a virgin state and covered with sagebrush and grasses.

The following table gives the results of a mechanical analysis of a sample of the surface soil of the Hyrum gravelly silt loam:

Hyrum gravelly silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
540729	Soil	1.4	2.3	2.3	7.0	28.7	50.9	7.8

OXFORD CLAY.

The surface soil of this type, to a depth of 12 to 18 inches, is a dark reddish brown or dull purplish brown to dark brownish red, rather silty clay. When viewed at a distance, plowed fields have a reddish cast, and when moist the red color is quite pronounced, the soils being referred to locally as "red soils." The subsoil, to a depth of 6 feet, is lighter reddish brown or pinkish to grayish, mottled with gray or white as a result of the concentration of lime. The subsoil is stratified and more compact than the surface soil.

When plowed in a wet condition, the soil has a tendency to clod, and when dry it bakes and cracks. Under favorable conditions of moisture and cultivation it is granular and friable. In a few localities, as indicated by exposures in cuts, the surface soil rests at 6 to 10 feet upon a layer of gray or pinkish gray joint clay, 2 or 3 feet thick, which in turn rests on a gray fine sand and fine sandy loam, 6 to 10 feet thick, where it is succeeded by a bed of fine gravel.

All the material in the lower part of the subsoil and substratum is stratified. In a few places long, narrow strips have had the surface soil largely removed, and the underlying strata of clay and gray sand are exposed. A small strip of this kind occurs about one-half mile southwest of Swanlake station and another small patch lies one-fourth mile east of Swan Lake.

The Oxford clay is of small extent, occurring as a margin or belt around the upper limits of the basin of ancient Lake Bonneville. The topography varies from smooth and gently sloping to rolling or erosional. Practically all the land has a surface favorable for cultivation. The type is derived from old lake-laid deposits having their source mainly in limestone. The materials were deposited in the waters of Lake Bonneville when it covered this part of the Cache Valley. The larger part of the Oxford clay is under cultivation. It is dry farmed, most of the land being fallowed every other year. Wheat is practically the only crop. The yields range from 20 to 35

bushels per acre, with an average of about 25 bushels. In its original state it supported a heavy growth of sagebrush. Land of this type sells for $25 to $60 an acre.

The results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Oxford clay are given in the following table:

Mechanical analyses of Oxford clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
540705	Soil	0.0	0.0	0.3	3.8	8.4	40.5	46.9
540706a	Subsoil	.0	.0	.0	.4	4.4	41.9	53.2
540706b	Lower subsoil	.0	.0	.0	5.4	7.2	44.6	42.9

TRENTON SILTY CLAY LOAM.

The surface soil of the Trenton silty clay loam consists of 12 to 15 inches of light grayish brown to brownish-gray silty clay loam, usually with a slight pinkish tint. The subsoil, to a depth of 5 feet, is a pinkish-gray or pinkish-brown to slightly salmon-colored somewhat compact clay or silty clay, mottled with white, yellow, red, or greenish colors.

There are a few flat poorly drained areas in which the surface soil is a dark-brown to nearly black silty to heavy plastic clay with a pinkish-gray, pinkish-brown, or gray subsoil of heavy texture. These areas, which are very small, have been on this account included with the Trenton, though they are not typical of the series.

This variation occurs in sections 26 and 27, R. 38 E., and along the line between sections 35 and 36, R. 38 E., about 1 mile southeast of Oxford. The Trenton silty clay loam is mapped only in Cache Valley in the southern part of Bannock County, in the area once occupied by Lake Bonneville. The type altogether occupies only a few square miles. It forms a part of the valley floor, and its topography is smooth or gently sloping to flat. Most of the type is flat and poorly drained. It occupies a lower position than the Oxford series. Only a small proportion of the land is under cultivation. This includes the better drained or marginal areas lying next to the Oxford soils on the east side of the valley. The soil contains more or less alkali, with traces of black alkali, as indicated by field tests. Much of the type is poorly drained and water-logged.

The native vegetation consists chiefly of greasewood and salt grass, with some sagebrush. The larger part of the type is used for pasture. The cultivated area is small, and the yields of crops only fair. A little wheat is grown, returning from 10 to 20 bushels per acre. In a few places near Oxford post office wild hay is cut. The

yield ranges from 1½ to 2 tons per acre. The land needs drainage, which over much of the type would be expensive, as there is apparently not sufficient fall to carry off the water, except through the installation of a comprehensive system of ditches and basins. Little or none of the type has been sold in recent years.

The following table gives the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Trenton silty clay loam:

Mechanical analyses of Trenton silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
540727	Soil	1.1	0.4	0.3	2.4	17.4	57.1	20.9
540728a	Subsoil	.4	1.3	.9	3.6	11.9	45.5	36.1
540728b	Lower subsoil	.0	.9	.6	3.0	10.3	43.7	41.4

ONYX LOAM.

The Onyx loam consists of 20 to 25 inches of medium-brown to dark-brown mellow loam of moderate to rather high organic matter content and usually moderately calcareous. The subsoil to a depth of 6 feet or more is a light-brown to a light grayish brown, somewhat more compact loam, generally containing much lime.

This type is fairly uniform in texture, color, and structure, but there are some variations that should be noted. In a few places, for instance, there is an admixture of fine gravel and larger rounded stone in the soil material, though nowhere in amounts sufficient to interfere with cultivation. Areas of this sort occur in the vicinity of the confluence of streams. Along the upper headwaters of the Portneuf River near the Bannock County line occurs another variation; here the soil is prevailingly dark brown.

The type occurs in comparatively narrow strips forming the first bottom land along the various stream courses. While the individual areas are not large, the total extent is considerable.

The topography is smooth and flat to gently sloping in the direction of the streams. As a whole, the Onyx loam, which includes the better-drained first bottom lands, is well drained. There are a few small tracts which are flat and wet, and low-lying areas are sometimes subject to overflow. There is little or no alkali present in this soil.

In its native state the type supports a growth of sagebrush with some willow and birch. The more favorable parts, where large enough for farming, have been put under cultivation; the rest is used for the production of wild hay and as pasture. From 1½ to 2 tons of hay per acre is obtained from the native grasses.

Wheat, sugar beets, alfalfa, and Irish potatoes are grown on the areas under cultivation. Wheat yields from 15 to 25 bushels, alfalfa from 2½ to 5 tons per acre per season, sugar beets from 12 to 15 tons, and Irish potatoes from 150 to 200 bushels per acre.

With good management excellent yields are obtained year after year. In most places it is not necessary to irrigate these crops, as the soil is naturally subirrigated and retentive of moisture. Land of this type sells for $40 to $60 an acre.

Onyx loam, light-textured phase.—The surface soil of the Onyx loam, light-textured phase, to a depth of 15 inches, is a brown to rather dark brown stony to gravelly fine sandy loam. The stone and gravel content is quite variable, though in few places sufficient to interfere with cultivation. The subsoil is a brown or gray stony loam, in which the stone content is large—in many places so large that the soil auger penetrates with difficulty below 15 inches. The proportion of rock fragments increases with depth and the substratum is a bed of bowlders and gravel. In a few places the subsoil material has a reddish-brown to yellowish cast, which is due to the oxidation of material resulting from the weathering of the gravel. The subsoil is calcareous.

This phase occupies recent alluvial fans built up at the mouths of small streams issuing from the steep mountain slopes. These fans are deposited upon old valley-filling materials. The material in them is mixed in origin, being derived in part from limestone, quartzite, and other rocks, and in part as washed from the surrounding loessial soils. The surface is gently sloping to rolling and steep, but for the most part it is favorable for cultivation. In its original state the Onyx loam, light-textured phase, supports a growth of sagebrush and grasses, with some birch and willow near the streams. A large proportion of the land is now under cultivation, especially the smoother and less stony parts.

Most of the cultivated land is used for the production of wheat, and there are a few fields in alfalfa. Wheat yields from 15 to 25 bushels on the better irrigated areas, which usually lie at the mouths of small drainageways on the lower levels. The higher lands situated at the foot of steep mountain slopes are seldom farmed, as they can not be irrigated and are too unretentive of moisture for successful dry farming. Where irrigated, alfalfa does fairly well, yielding from 2 to 4 tons per acre per season. While there are no large bodies of this phase, its total extent is considerable. It is sold in conjunction with the adjacent soils.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the typical Onyx loam and of the soil of the light-textured phase:

Mechanical analyses of Onyx loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
Typical soil:		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
540701	Soil	0.0	0.2	0.2	2.6	35.2	46.5	15.0
540702	Subsoil	.0	.0	.6	2.4	29.1	50.4	17.5
Light-textured phase:								
540743	Soil	4.0	5.5	1.8	6.8	35.4	35.4	11.2

SNAKE FINE SANDY LOAM.

The surface soil of the Snake fine sandy loam, to a depth of 12 to 18 inches, is a light-brown to grayish-brown fine sandy loam of open friable structure and low organic matter content. In a few places the soil approaches in texture a fine sand, but as a whole the silt and clay material is present in sufficient quantities to render it a fine sandy loam. The subsoil to a depth of 5 or 6 feet is a gray to dark-gray sand, consisting of a mixture of light-colored quartz and dark-colored to nearly black basalt particles, and is similar in color and character to that occurring in the soils of the Winchester series.

A variation of this type occurs immediately along the banks and channels of the Snake River. Here the type represents riverwash, consisting of loose porous flood swept sands and gravels. This variation is not extensive and for this reason is not mapped separately. It is of no agricultural importance.

The Snake fine sandy loam occurs in the first bottoms of the Snake River. It has a smooth gently sloping to slightly ridged topography. Practically all of it is subject to overflow. The materials forming this soil came originally from basalt, quartzite, quartz, rhyolite, and other rocks.

None of the type, which lies within the Fort Hall Indian Reservation, is farmed. It supports a rank growth of sagebrush and grasses. This type is better drained than the clay of the series and contains little or no alkali.

The following table gives the result of mechanical analysis of a sample of the soil of the Snake fine sandy loam:

Mechanical analysis of Snake fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
540703	Soil	0.0	0.0	0.3	13.3	46.2	29.5	10.8

SNAKE CLAY.

The Snake clay consists of 15 to 18 inches of dark-brown to dark grayish brown calcareous clay, containing moderate to large proportions of organic matter, underlain at a depth of 6 feet or more by a brownish-gray to gray clay to silty clay of marly character. There are some included depressions or swales where the surface soil is nearly black in color and slightly heavier in texture. In a few borings a layer of peaty material was encountered at 40 to 50 inches below the surface. The substratum consists of rounded, river-laid gravel.

In a few localities the gravel bed is exposed, and here a gravelly type of soil is developed, but owing to its small extent it is included with the clay and shown on the soil map by gravel symbols. The Snake clay occurs in the Snake River flood plain. The topography is for the most part smooth and level, except for a gentle slope in the direction of stream flow. A few slight swells or ridges, with intervening depressions or swales, give a slight unevenness to parts of the type.

The land is rather poorly drained, and practically all of it contains more or less alkali, tests showing both white alkali and black alkali.

The soil material owes its origin to transportation and deposition of recent alluvial material by the waters of Snake River. In ultimate origin the materials are mixed, coming in part from basalt, quartzite, rhyolite, limestone, and other consolidated rocks, and in part from loessial and old lake-laid materials. None of the type is used for the production of cultivated crops, but it has some value as pasture and for the production of wild hay. The vegetation consists of greasewood, sagebrush, and a good growth of grasses, among them marsh grass and salt grass.

All the type lies within the Fort Hall Indian Reservation. It needs drainage and reclamation from its alkali condition. It is best suited to the growing of hay crops.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Snake clay:

Mechanical analyses of Snake clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
540709	Soil	0.6	1.4	1.2	10.1	10.7	39.1	37.0
540710	Subsoil	.5	.6	.5	3.8	13.0	33.6	48.2

LOGAN FINE SANDY LOAM.

The surface soil of the Logan fine sandy loam, to a depth of 15 inches, is a dark brownish gray to dark grayish brown fine sandy loam of friable structure. In texture the subsoil is similar to or but little heavier than the surface soil, which it also resembles in color, being if anything a little grayer.

In texture of surface and subsoil material, however, this type is quite variable from place to place, ranging from a sandy loam to fine sand. The sand material consists largely of quartz and basalt particles. In many places numerous small fragments of fresh-water shells are scattered through the soil material. Both surface and subsoil material are high in lime.

The Logan fine sandy loam is of small extent. It occurs in small tracts along the Portneuf River, one near Portneuf and others between Lava Hot Springs and Blaser School. The type occupies the smooth first bottoms and as a result of its porous structure is well drained.

The soil materials come from many different kinds of rocks and have been reworked and deposited by the Portneuf River. From the place of occurrence and the shells present in the soil it would appear that some material was deposited in quiet, shallow water, at a time when the stream was dammed near Portneuf by the lava flow and above Lava Hot Springs, when the stream level was raised by the deposition of the calcareous tufa by the waters from mineral springs at that place.

Little or none of the type is farmed, but it would seem to be best suited to the production of truck crops and Irish potatoes. The land is sold only in conjunction with the surrounding types of soil.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Logan fine sandy loam:

Mechanical analyses of Logan fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
540735	Soil	0.4	4.5	4.1	35.7	28.7	19 9	7.1
540736	Subsoil	.6	7.5	6.4	26.2	26.5	23.5	9.6

LOGAN SILTY CLAY LOAM.

The surface soil of the Logan silty clay loam, to a depth of 18 to 20 inches, is a dark-gray to black silty clay loam of heavy texture and in places approximating silty clay. In the more poorly drained areas, indicated on the map by marsh symbols, the immediate surface is dark-gray peaty material. The subsoil to a depth of 6 feet

or more is a dark gray or yellowish gray to drab silty clay to clay, normally heavy and compact.

There are included a few areas in which the surface soil is a nearly black silty clay to plastic clay to a depth of 30 inches or more, where it rests upon a gray impervious clay. The largest tract of this variation occurs along the Portneuf River near Pebble, and there is a small area lying along Marsh Creek near Zenda. The small extent of this heavier soil did not justify the mapping of a clay type of the Logan series.

The Logan silty clay loam occupies the low, flat, poorly drained first bottoms along the Portneuf River and Marsh Creek, where it is relatively extensive. A small area lies along Fish Creek. The surface is nearly level, with a gentle slope in the direction of stream flow. The larger part of the type is poorly drained, the land remaining in a moist condition throughout the year. There are a few places where there is an accumulation of alkali salts.

The type owes its origin to deposition of stream-borne materials of mixed origin, but largely derived from limestone and eolian deposits. Being a recently deposited soil derived from highly calcareous material and not having been subjected to important changes since deposition, both the surface soil and subsoil are calcareous.

In its native state the type supports a heavy growth of grasses, with some willow, birch, and other water-loving flora. Very little of the type is farmed. Most of it is used as pasture and for the production of wild hay, which yields from 2 to 2½ tons per acre. Land of this type ranges in price from $25 to $40 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Logan silty clay loam:

Mechanical analyses of Logan silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
540731	Soil	0.2	2.4	2.2	6.4	9.9	50.3	28.0
540732	Subsoil	.1	3.1	3.4	9.9	8.0	42.8	32.4

M'CAMMON LOAM.

The McCammon loam consists of 15 to 20 inches of brown to rather dark brown loam, underlain by a lighter brown to grayish-brown or reddish-brown compact silty loam to depths ranging between 36 and 60 inches. The basaltic rock bed in most places lies at depths between 36 and 60 inches, and fragments of this rock are scattered through the soil and subsoil.

In places the rock outcrops on the surface, but such areas are for the most part small. The more important are indicated on the map

by symbols. The type is fairly high in organic matter. The material is calcareous at a slight depth below the surface. Areas of this soil occur in the vicinity of McCammon. The total area is, however, only a few square miles. The topography is smooth and gently sloping to undulating and favorable for cultivation.

The type owes its origin to the weathering in place of the basalt rock which underlies it, and to the admixture of fine dustlike eolian deposits with the residual material in the surface soil. A little stream-laid material has influenced its formation in places where the waters of the Portneuf River flowed over the lava. The rounded stones and gravel found in the type in a few places are remnants of these stream deposits.

Practically all the McCammon loam is under cultivation. Wheat, alfalfa, and sugar beets are grown to the exclusion of other crops. The land is irrigated from a ditch taken out of the Portneuf River a few miles above McCammon. Chiefly winter wheat is grown. The yield of wheat ranges from 25 to 30 bushels per acre. Sugar beets do well, yielding on the average about 15 tons per acre. Alfalfa yields from 2 to 4 tons per acre per season. Land of this type is held at $35 to $60 an acre.

McCammon loam, shallow phase.—The surface and subsoil material of the McCammon loam, shallow phase, is similar in color and texture to the typical soil. The phase occurs where the basalt rock, which everywhere underlies the type, comes within a few inches of the surface. The depth of the soil and subsoil material ranges usually from 6 to 12 inches.

Outcrops of the basalt are common and the soil is so shallow and stony that very little of it is cultivated.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the typical McCammon loam:

Mechanical analyses of McCammon loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
540733	Soil	0.4	1.4	1.4	10.9	33.1	39.2	13.6
540734	Subsoil	.4	.4	.4	4.4	34.9	41.5	18.0

ROUGH MOUNTAINOUS LAND.

Rough mountainous land includes the areas badly dissected by ravines and stream courses, where the topography is too steep and broken for farming. Practically all the soil material is stony and shallow. The fine-earth material is prevailingly a light-brown, brown, or dark-brown very fine sandy loam, silt loam, or loam, underlain by a lighter brown, slightly reddish brown, or grayish

compact silt subsoil. The material, however, includes variations in texture and color, as no attempt was made to map the nonagricultural land on the basis of soil types.

Rough mountainous land occupies the more broken parts of the Bannock and Portneuf Ranges. Outcrops of the underlying quartzite, limestone, and other rocks are common over all the type. Only a few scattered tracts could be plowed, owing to the stony and broken character of the type, and the land is suited only for grazing and forestry. A large part of the type occurs within the Cache National Forest. It supports a scattered growth of pine, juniper, aspen, and cottonwood, with some birch and willow along the stream courses.

There is also a growth of grasses and the land is of considerable value for pasture. Sheep, cattle, and a few horses are grazed upon it.

The type as a whole is nonagricultural, but small scattered areas, in most cases containing a few acres, are capable of cultivation.

ROUGH STONY LAND.

Rough stony land is confined to steep, broken slopes on which there is much fragmentary rock with only a thin mantle of soil, if any, over the underlying bedrock. The land has no value for agriculture and only a little for grazing. A scrubby growth of pine and cedar occurs in places. The type, which is closely associated with Rough mountainous land, is not extensive.

ROUGH BROKEN LAND.

The soil material classified as Rough broken land ranges in character from a stony loam to silt loam, having a brown to gray color This material occupies the steep, rough, broken, and badly dissected areas occurring along stream courses and forming escarpments between the first bottom lands and the gently sloping to rolling upland bench lands.

It occurs principally as narrow strips along the escarpments. It is typically nonagricultural, having no value for cultivated crops, but some value as pasture, for which it is used almost exclusively.

SCABLAND.

Scabland occupies steep basaltic cliffs or escarpments, and the associated flat, smooth or slightly irregular surfaces of the lava flows. The soil material is shallow, stony, and similar in color and character to the soils of the McCammon series. Basalt outcrops over practically all the type. None of the type is farmed, being too stony, shallow, and rocky to admit cultivation. The type supports a growth of sagebrush and wild grasses and is used for grazing.

The type occupies areas of basaltic lava flows in the Snake River Plains and along the Portneuf River.

MUCK AND PEAT.

The surface material of Muck and Peat consists chiefly of brown to black vegetable matter in various stages of decay, with which is mixed varying quantities of fine mineral particles. This is underlain at a depth of 40 to 60 inches by a gray to drab clay. The browner material is more fibrous, stems and fragments of plants being conspicuous, and contains but little mineral material. This is Peat.

The Muck is darker colored, more completely decomposed, and therefore less fibrous or spongy in structure. It also differs from Peat in having a higher content of the mineral constituents of soils.

The type occupies low, poorly drained areas along Ross Fork Creek and depressions or swales in the Snake River bottoms. It is moist or wet throughout the year and supports a growth of cat-tails, lillies, and other water-loving flora. There is less than 1 square mile of these organic soils in the area, and they are thus of minor importance.

IRRIGATION.

The larger part of the cultivated lands of the area surveyed is dry-farmed. Much of this is rolling and too broken for irrigation, except at a very high cost. Fair average yields of grain are obtained, except in the more arid parts, under the prevailing dry-farming methods, in which the practice of summer fallowing in alternate years is followed.

The irrigated lands of the area produce good yields of grain, alfalfa, sugar beets, and potatoes year after year. The Snake River Plains are irrigated by the Fort Hall Irrigation Project Canal. This system covers parts of the northwestern part of Bannock County and southern Bingham County. The waters are stored in the Blackfoot Reservoir, near the head of the Blackfoot River, which is located about 15 miles north of Soda Springs.

The east side of Marsh Creek Valley from Arimo southward to Downey is watered by the system of the Portneuf-Marsh Valley Irrigation Canal. There are a number of smaller irrigated sections. The Marsh Center irrigation reservoir is located in Hawkins Basin. It is a small system supplying water to areas along Hawkins Creek and in the vicinity of Marsh Center School. The Sunnyside Basin country and the country around McCammon are irrigated by small ditches. Several farmers have private ditches taking water from the smaller streams.

Crops are watered both by the furrow and the flooding systems. The fields are irrigated from two to five times, depending on the season and crop.

ALKALI.

Owing to prevailing well-established drainage of the larger part of the area, conditions have not favored the accumulation of alkali salts. There are, however, a few localities where such accumulation has taken place.

The principal occurrence of alkali is in the Trenton soils in the Cache Valley, in the Snake River bottoms, and as local spots in the elevated parts of the Snake River Plains. In these localities the level of ground water is normally high and the alkali has been concentrated through evaporation at the surface. The spots are easily distinguished by the presence of alkali crusts, the occurrence of salt grass and other alkali resistant plants, and by barren spots in the cultivated fields.

In the Trenton silty clay loam in Cache Valley there are frequent spots of alkali accumulation. A few tests of the affected spots were made in the field by the electrolytic bridge method and the results indicated the average alkali content to be about 0.20 to 0.40 per cent total salts.

Here there was only a slight trace of black alkali present, but similar tests of samples of soil from affected spots in the Snake clay in the Snake River bottoms showed a slightly higher percentage of alkali than the Trenton soils, varying from 0.25 to 0.45 total salts, and tests made for black alkali indicated a relatively large proportion of such salts.

In the old valley-filling soils of the Snake River Plains affected areas contained from 0.15 to 0.32 per cent alkali. There was only a trace of black alkali here.

On account of the small amount of alkali present in the soils and the restricted area affected there was no separate alkali map made, but the areas are indicated on the accompanying soil map by inclosure within red lines; the spotted areas by a broken red line with the symbol S, and the more uniformly affected areas by a solid red line with the letter A.

SUMMARY.

The area covered by this survey lies in the southeastern part of Idaho and includes the western part of Bannock County. It comprises 1,162 square miles, or 743,680 acres.

The area includes several valleys, among which are Marsh Creek Valley, Hawkins and Garden Creek Basins, a part of Cache Valley, Cottonwood Creek Basin, and the Snake River Plains. The Bannock Range of mountains forms the western boundary of the area, and the Portneuf Range lies along the east side. The drainage is principally into Snake River through the Portneuf River and its tribu-

taries. A small proportion of the territory drains into Bear River, which flows south into Great Salt Lake.

The first settlements were made in the Marsh Creek Valley in the early sixties. A large part of the population is engaged in farming, most of the farms being operated by the owners.

The principal farming areas are well supplied with transportation facilities.

Pocatello, the county seat of Bannock County, is the principal city. There are several other small towns and villages in the area.

The mean annual temperature at Pocatello is 47.6° F. The maximum summer temperature recorded is 102° F., and the minimum for winter is —20° F. The mean annual precipitation is 12.93 inches. The average date of the last killing frost in spring is April 28 and the earliest in the fall, October 5. The prevailing winds are from the southwest.

Wheat, alfalfa, sugar beets, oats, rye, barley, and potatoes are the leading crops. Considerable dairy farming is carried on. Hogs, cattle, sheep, and horses are raised. Stock raising constitutes one of the principal industries. Wheat, sugar beets, and live stock are shipped from the area to outside markets.

The larger part of the area is dry farmed, but the irrigated area is considerable. The larger part of the land is practically free from alkali, the only areas affected occurring as spots on heavier soils of the Trenton, Snake, and Bannock series.

Thirteen soil series, comprising 16 soil types and 6 phases, and 5 miscellaneous types are mapped. The upland soils range in color from gray or light brown to dark brown and the bottom soils from brown to black.

Soils of the Portneuf series occur in the northwestern part of the area. The soils are gray in color, are highly calcareous, and are derived from wind-borne loessial deposits. The series is represented by a single type of soil, which occurs under arid conditions and of which only a small part is under cultivation. With this series, however, have been included as phase variations small areas of recent alluvial-fan soils formed mainly by erosion and redeposition of material derived from the loessial Portneuf soils, and which are farmed to some extent, in part under irrigation.

The Ritzville series comprises a large part of the farming land of the area. The series is eolian or loessial in origin. One type, the Ritzville silt loam, is developed in this survey. It is practically all under cultivation.

The Walla Walla series occurs in regions of low rainfall. One type, the silt loam, is mapped.

The soils of the Winchester series are of small extent and occur only in the northwestern part of the area. The soils are composed

of wind-blown material. Two types, a fine sand and a sandy loam, are developed in the area. The former is not farmed; the latter gives good yields of alfalfa and other crops under irrigation.

The soils of the Bannock series have been derived from old valley-filling deposits, which have been modified in place and influenced by eolian deposits. The series is found on the Snake River plains and in the Marsh Creek Valley. One type and two phases are mapped. It is a productive soil.

The Downey series represents old stream-laid deposits, having a cemented substratum of stone and gravel. The surface soil consists in part of eolian material. This series occurs near the town of Downey. It is represented by only one type, a silt loam. Under irrigation this soil produces good crops of alfalfa, wheat, sugar beets, and potatoes.

The Hyrum series represents old stream-laid deposits, with a porous, gravelly substratum. It is of small extent. It is used for pasture and is a source of gravel for ballasting railroads and for building.

The Oxford series is derived from old lake-laid deposits. Only one type, a clay, is mapped. It is well drained.

The Trenton series represents a deposit of Lake Bonneville. The only soil mapped, the silty clay loam, is poorly drained and somewhat affected with alkali. A small portion of this soil is cultivated.

The Onyx series represents brown soils of alluvial origin. One type, the loam, with a light-textured phase, is mapped. The better areas are cultivated. The rest is used for the production of wild hay and for pasture.

The Snake series represents the grayish-brown to dark grayish brown soils occurring in the first bottoms of the Snake River. Two types are mapped, a fine sandy loam and a clay. The present uses of these soils is for the production of wild hay and as pasture.

The Logan series represents the dark-gray to black poorly drained recent alluvial soils. Two types of this series occur in the area, a fine sandy loam and silty clay loam. Little of this land is farmed, but it offers opportunity for the production of potatoes and truck crops.

The McCammon series comprises the only residual soils mapped in the area. The series is derived from basalt. One type and a phase are mapped. Most of the area of these soils is farmed.

The miscellaneous soils are mainly nonagricultural. Some of them have value as grazing land. Areas mapped as Muck and Peat are poorly drained. The area of these organic soils is very small. None of this land is farmed at present.

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[PUBLIC RESOLUTION—No. 9.]

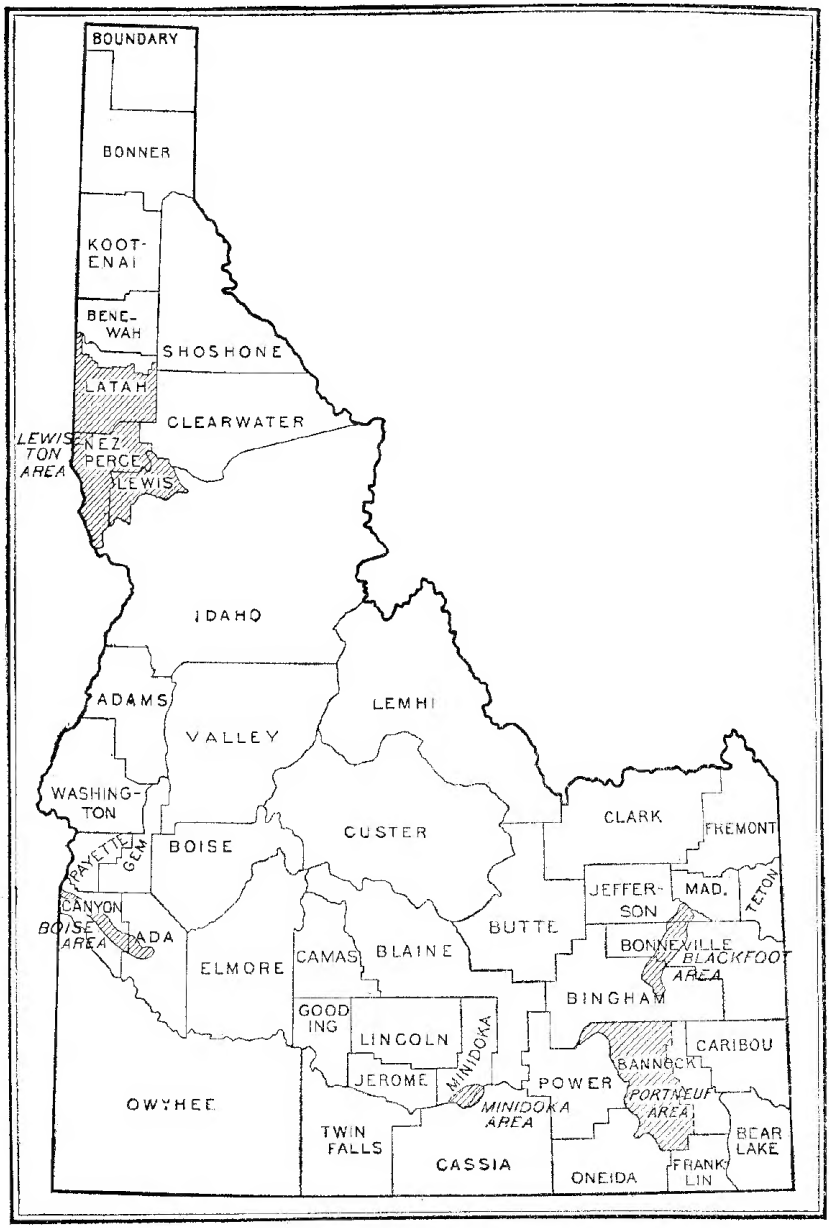
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]



Areas surveyed in Idaho.

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U. S. DEPT. OF AGRICULTURE
BUREAU OF SOILS
MILTON WHITNEY, CHIEF
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

SOIL MAP
IDAHO
PORTNEUF AREA SHEET

UNIVERSITY OF IDAHO
AGRICULTURAL EXPERIMENT STATION
E. J. IDDINGS, DIRECTOR

LEGEND

- Bannock very fine sandy loam — Bs
- Bs — Shallow phase
- Bs — Stony phase
- Portneuf very fine sandy loam — Ps
- Portneuf silt loam, Alluvial fan phase — Pl
- Portneuf silty clay loam, Alluvial fan phase — Pc
- Downey silt loam — Dl
- Ritzville silt loam — Rs
- Hyrum gravelly silt loam — Hs
- Snake fine sandy loam — Ss
- Logan fine sandy loam — Ll
- Snake clay — Sc
- Logan silty clay loam — Ls
- Trenton silty clay loam — Ts
- McCammon loam — Mc
- Mc — Shallow phase
- Walla Walla silt loam — Ww
- Winchester fine sand — We
- Onyx loam — Ol
- Winchester sandy loam — Wl
- Ol — Light-textured phase
- Rough broken land — Rb
- Oxford clay — Oc
- Rough mountainous land — Rm
- Muck and Peat — Mp
- Rough stony land — Rl
- Scabland — S
- Alkali present — A
- Alkali present in spots — S

CONVENTIONAL SIGNS

CULTURE
(Printed in black)

City or Village, Roads, Buildings, Wharves, Jetties, Breakwater, Levee, Lighthouse, Fort
Secondary roads and Trails
Railroads, Steam and Electric
Bridges, Ferry
R.R. crossings, Tunnel
Ford, Dam
School or Church, Cemeteries
Mine or Quarry, Mine dumps, Made land
Bluff, Escarpment, Rock outcrop, and Triangulation station
Stony and Gravelly areas
Soil boundaries
Boundary lines
Boundary lines
Boundary lines
U.S. township and section lines

RELIEF
(Printed in brown or black)

Contours, Depression contours
Prominent Hills, Mountain Peaks
Sand Wash, and Sand dunes
Shore and Low-water line, Sandbar

DRAINAGE
(Printed in blue)

Streams
Lakes, Ponds, Intermittent lakes
Intermittent streams
Springs, Canals and Ditches, Flumes
Swamp, Salt marshes
Submarged marsh, Tidal flats

The above signs are in current use on the soil maps. Variations from this usage appear in some maps of earlier dates.

Macy H. Lapham, Inspector, Western Division.
Soils surveyed by H. G. Lewis of the U. S. Department of Agriculture, in charge and P. P. Peterson of the University of Idaho.

Scale 1 inch = 1 mile
1 ½ 0 1 2 3 4 Miles

Field Operations
Bureau of Soils
1918